

University of Wisconsin-Extension

GEOLOGICAL AND NATURAL HISTORY SURVEY
3817 Mineral Point Road
Madison, Wisconsin 53705

J.M. Robertson, State Geologist and Director

Variability of Hydraulic Conductivity in Sandy Till:
The Effects of Scale and Method

by

Todd W. Rayne

Open-File Report 93-4
290 p.

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1993

Supplemental Material

This section is a collection of hydraulic conductivity tests that accompanies a dissertation titled *Variability of hydraulic conductivity in sandy till: the effects of scale and method* (Rayne, 1993). The test results are from piezometer tests, borehole dilution tests, and pumping tests. The raw test data are not presented, but the graphical solutions are shown. Test label prefixes R and CC refer to wells at site 1 and site 2, respectively.

The first group of test results are piezometer tests conducted using a solid plastic slug to raise or lower the water level about one foot. These tests are referred to as *slug tests* in the dissertation. The graphs are from the test solution software AQTESOLV (Geraghty and Miller, 1989). The solution method is after Bouwer and Rice (1976) and Bouwer (1989). Hydraulic conductivity and y intercept values are listed on the graph of drawdown versus time. Details of the test procedure and a summary of results can be found in Rayne (1993).

The second set of piezometer tests were performed using a bailer or suction pump to lower the water level in the well about 10 feet. These tests are referred to as *bail tests* in the dissertation. The solution method is the same as for the slug tests, and solved using AQTESOLV. Some of the graphs of drawdown versus time show a concave downward shape. The reason for this shape is unknown; several explanations were considered and rejected. This is discussed briefly in Rayne (1993). Note that hydraulic conductivity was analyzed for different parts of the curve on some of the graphs. This was performed to look for a relationship between the steeper slope and the hydraulic conductivity from slug tests. Details of the bail test procedure and a summary of results can be found in Rayne (1993).

The third section contains results of borehole dilution tests. These tests were performed in twenty wells between the two field sites. Details of the test and solution procedures are described in Rayne (1993). A sample calculation and calculated velocities from each test are shown in this section.

Results from pumping tests at both sites are contained in the fourth section. Graphs of drawdown versus time and calculations for all observation wells that showed measurable drawdown are included. Several solution methods were used, with consistent results. Data from Site 1 were analyzed using the method of Boulton (1963) and Neuman (1974, 1975). The former is a curve-matching method

that assumes full penetration of the pumping and observations wells. The latter method was used by AQTESOLV and included partial penetration of both the pumping and observations wells. The graphs include the solved transmissivity, storage coefficients, delayed yield information. Data from Site 2 was analyzed using the method of Hantush and Jacob (1955) and Hantush (1960). These methods are for leaky confined aquifers and can incorporate partial penetration. These data were analyzed using AQTESOLV, and the graphs include the transmissivity, storage coefficient, and the leakage term.

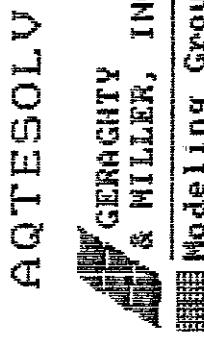
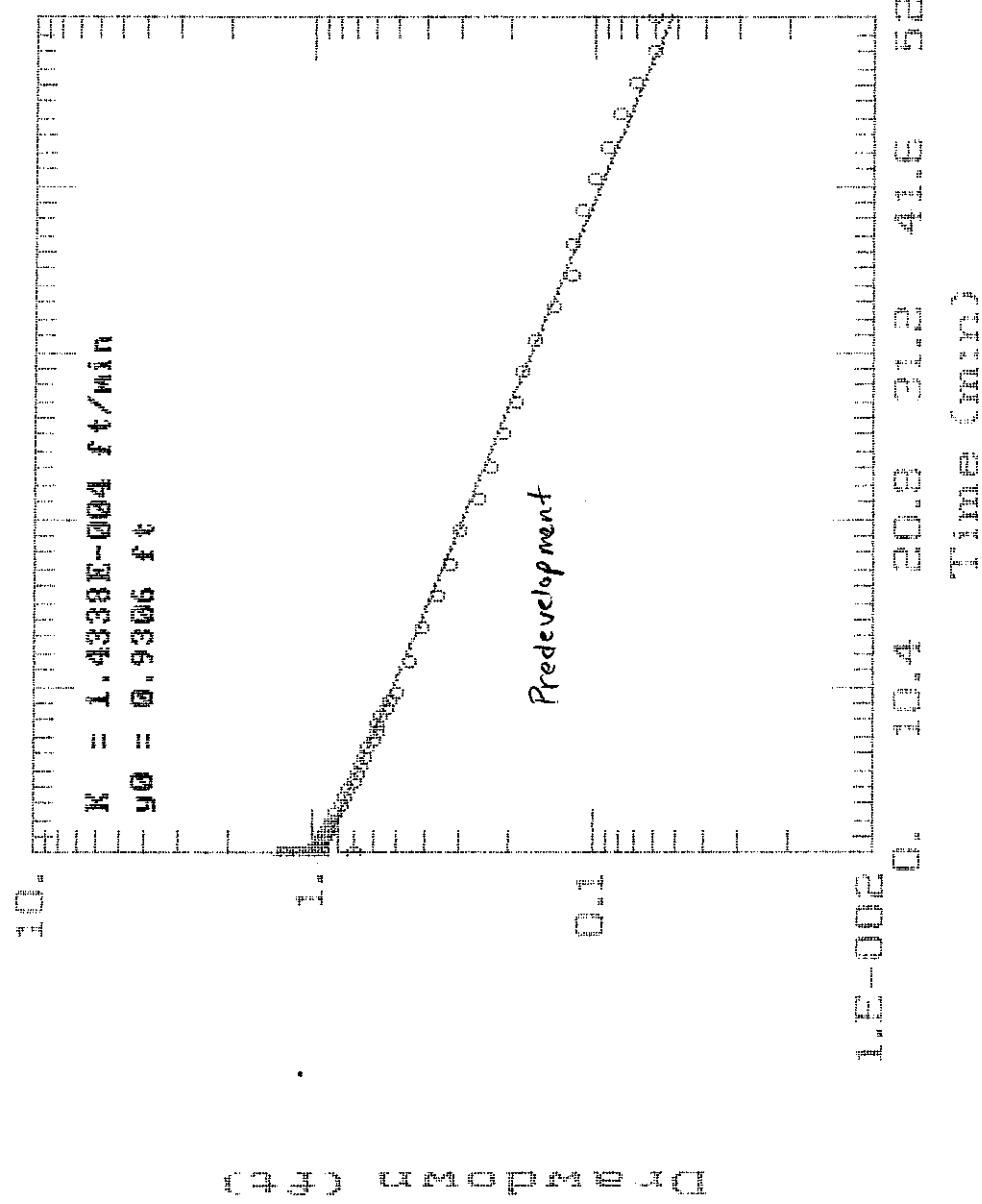
References

- AQTESOLV, Aquifer test solver, version 1.1: Geraghty and Miller Modeling Group, Reston, VA, 1989.
- Boulton, N.S., 1963, Analysis of data from nonequilibrium pumping tests allowing for delayed yield from storage: Proc. Inst. Civil Engineers, v. 26, p. 469-482.
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- Neuman, S.P., 1972, Theory of flow in unconfined aquifers considering delayed response of the water table: Water Resources Research, v. 8, p. 1031-1045.
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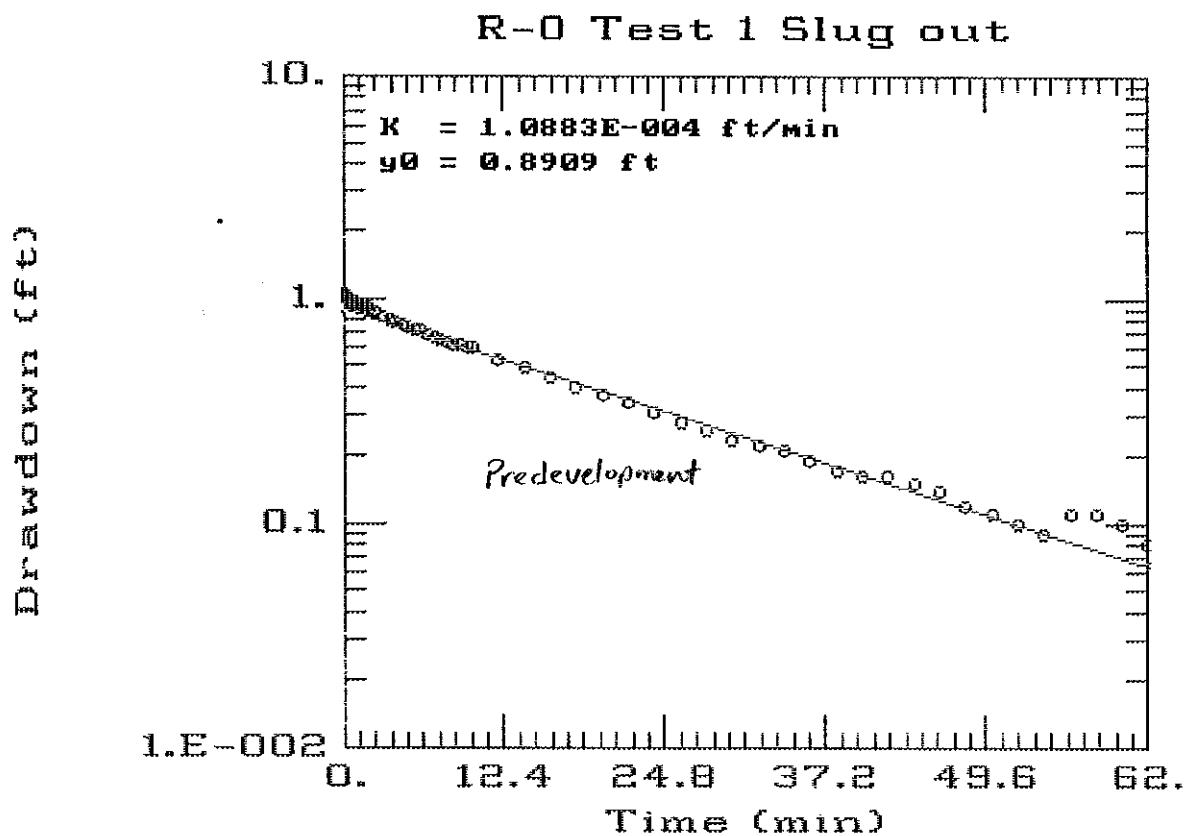
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Piezometer (slug in and slug out) tests - Site 1

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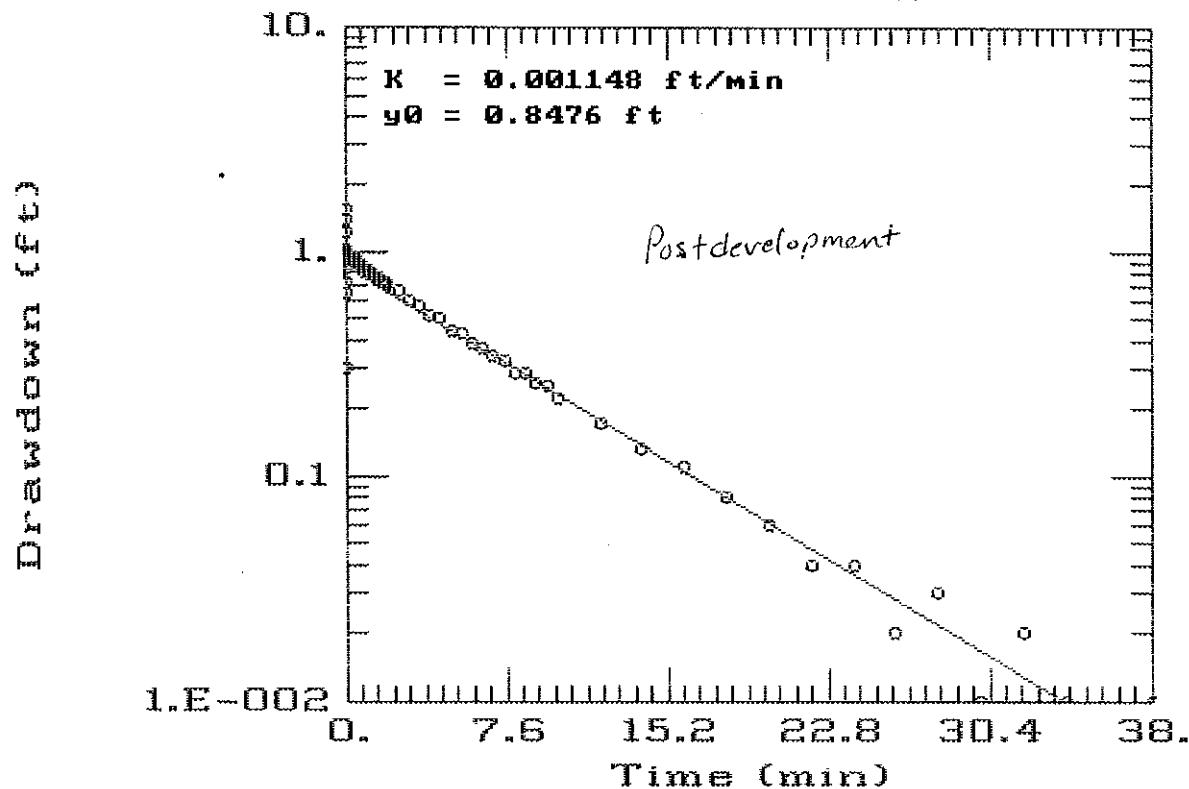


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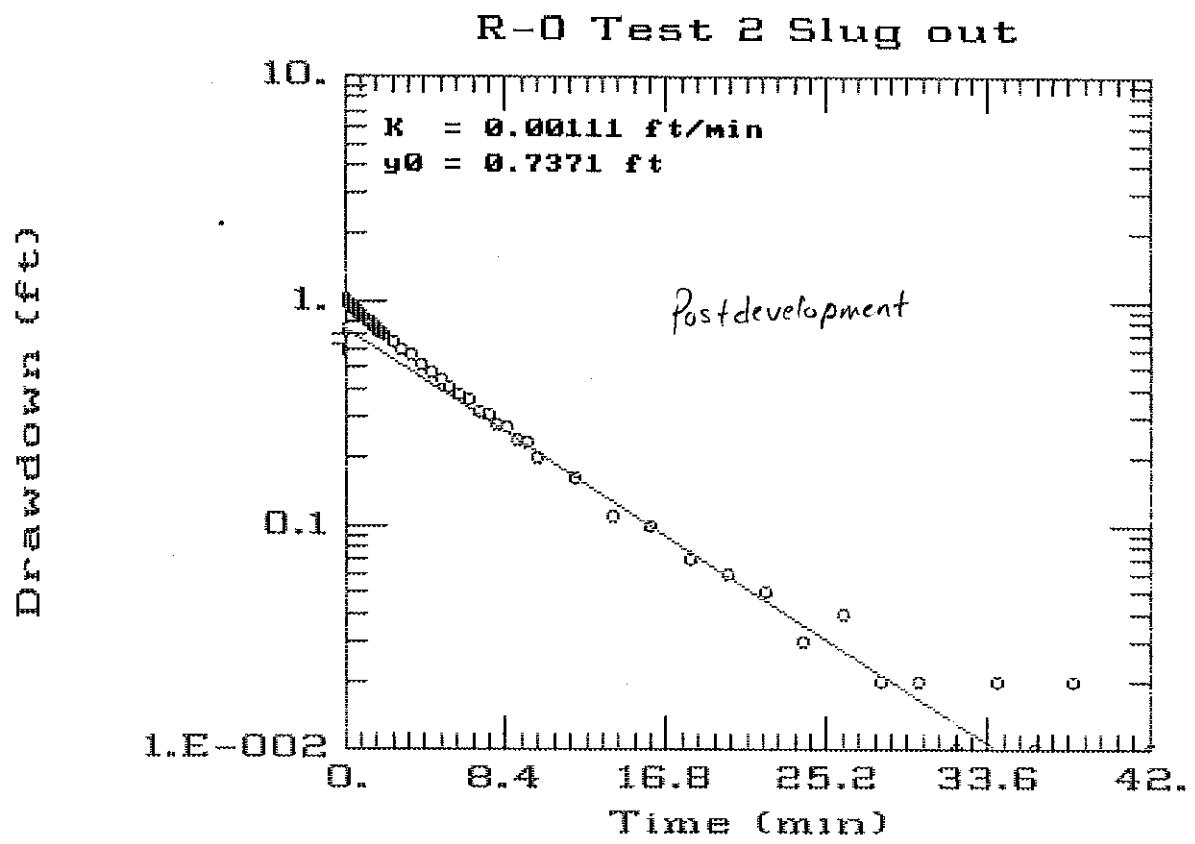
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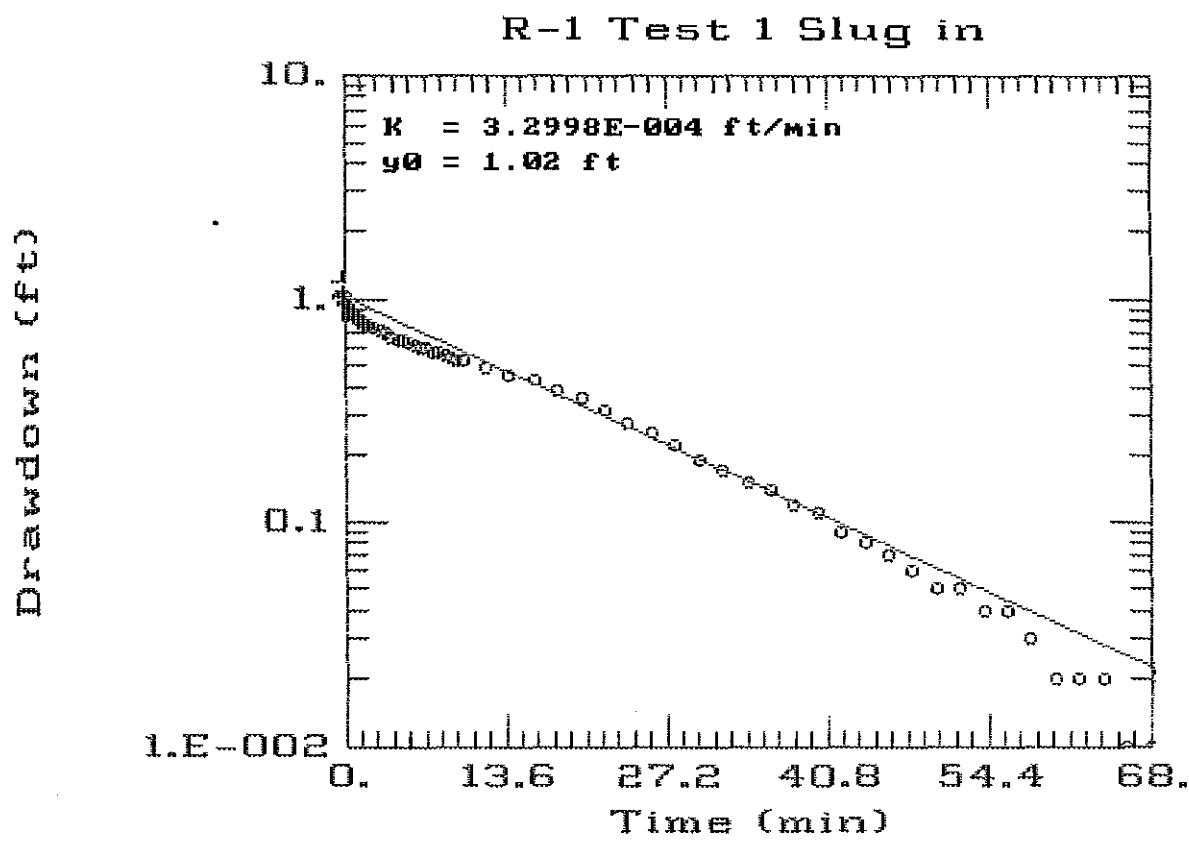
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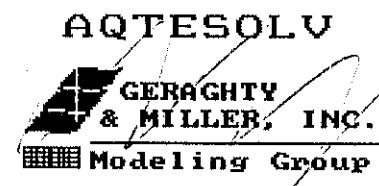
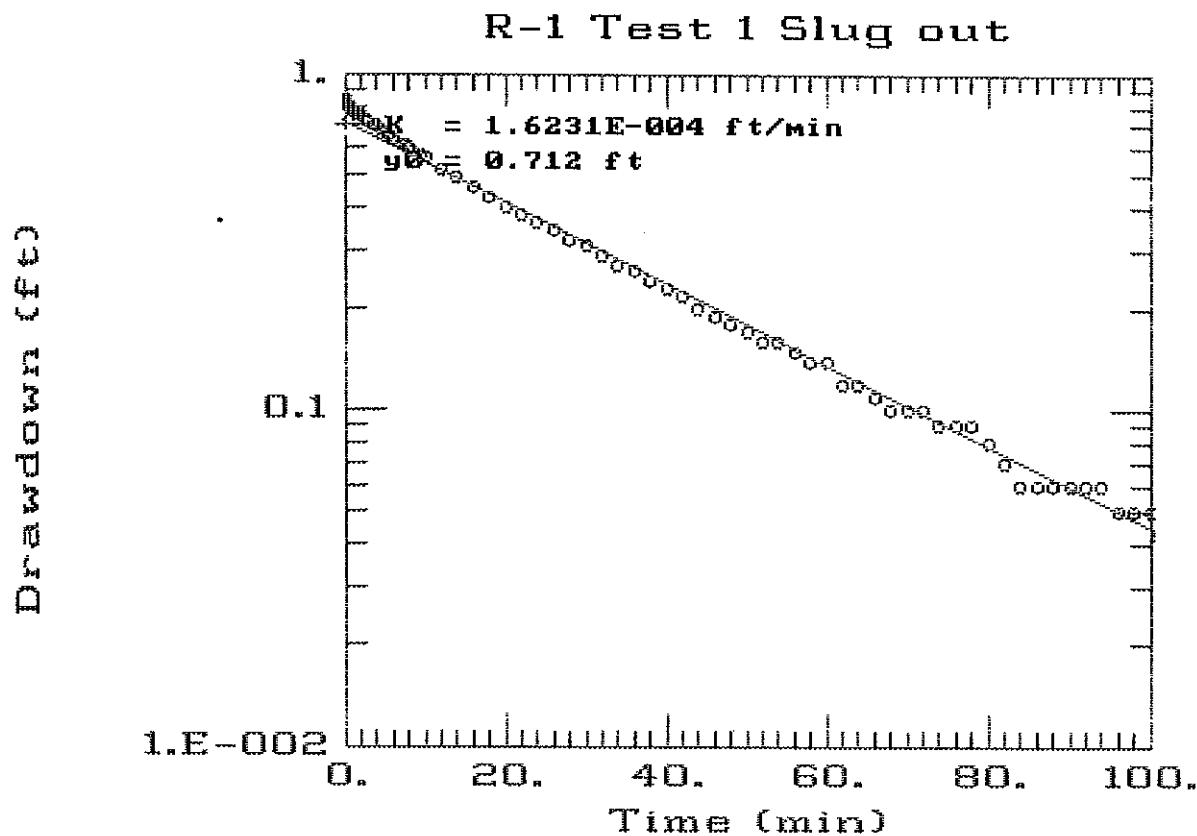


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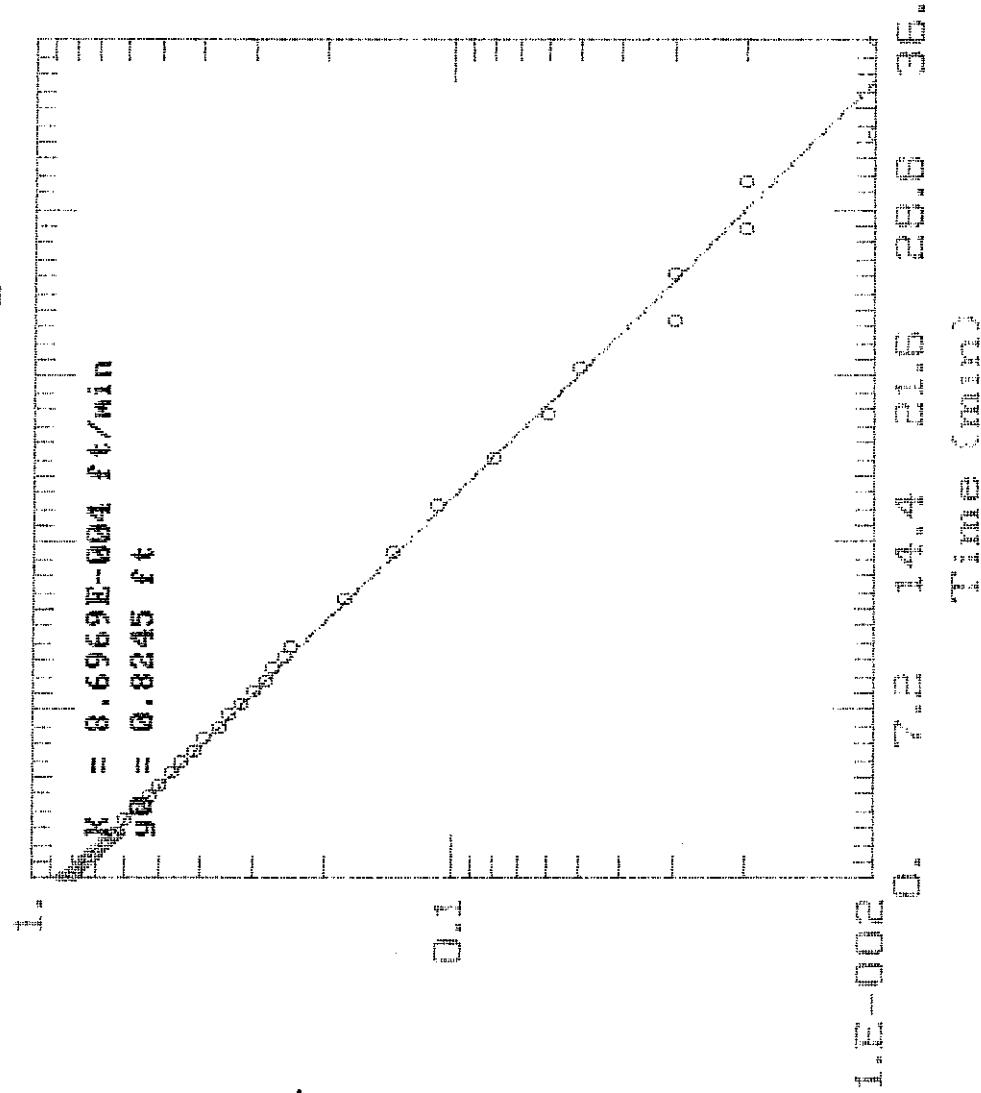
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Modeling Growth

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R-2 Test 1 Slug in

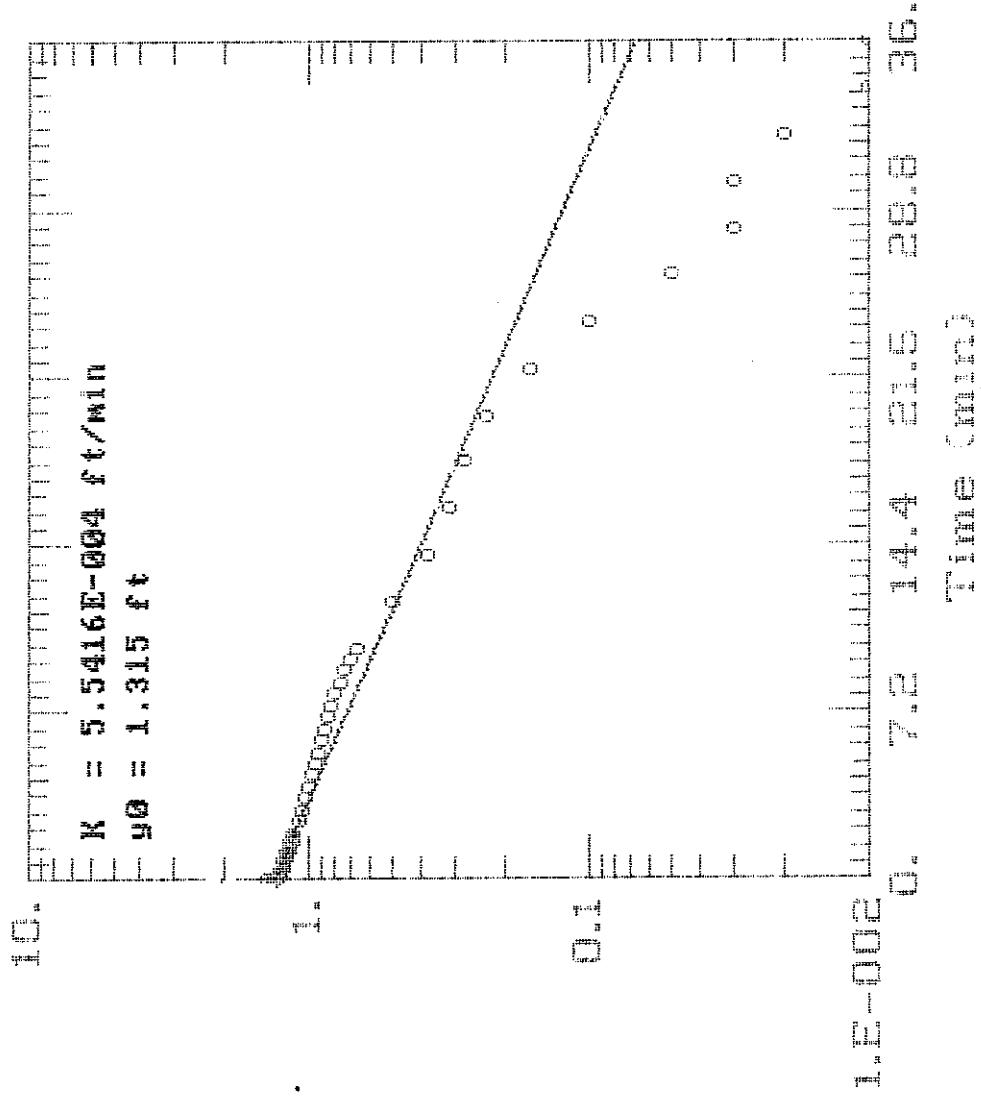
6 2 4 3 U F1 O P F1 E A G

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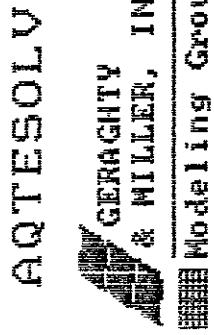
R-2 Test 1 Slug out

$$K = 5.5416E-004 \text{ ft/min}$$

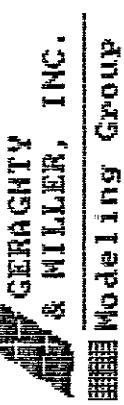
$$y_0 = 1.315 \text{ ft}$$



04-00 LUMINAIR INC



00012

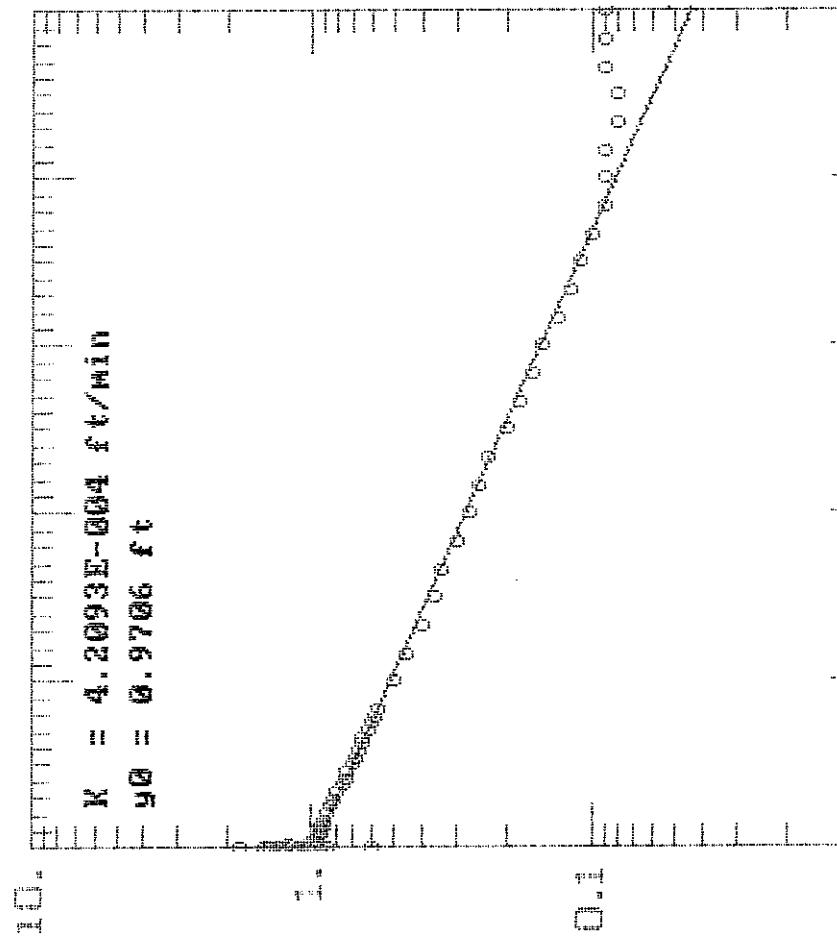


Modeling Group

Time (hours)

1.E-002 0. 12. 24. 36. 48. 60.

AQTESOLV



R-3 Test 1 Slug in

$$K = 4.2093E-004 \text{ ft/min}$$
$$q_0 = 0.9706 \text{ ft}$$

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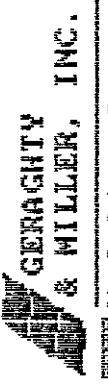
R-4 Test 1 Slug in

$$K = 2.1054E-005 \text{ ft/min}$$

$$q_0 = 0.721 \text{ ft}$$

0 4 8 12 16 20 24 28 32 36 40

AQTESOLV



Modeling Group

TIME (min)

0.1 0.5 1 2 5 8 25 40 30 45 50 54

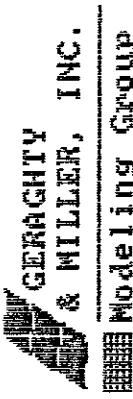
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R-4 Test 1 Slug out

$$K = 6.5632E-006 \text{ ft/min}$$

(44) Grand Prairie

AQTESOLV



Modeling Group

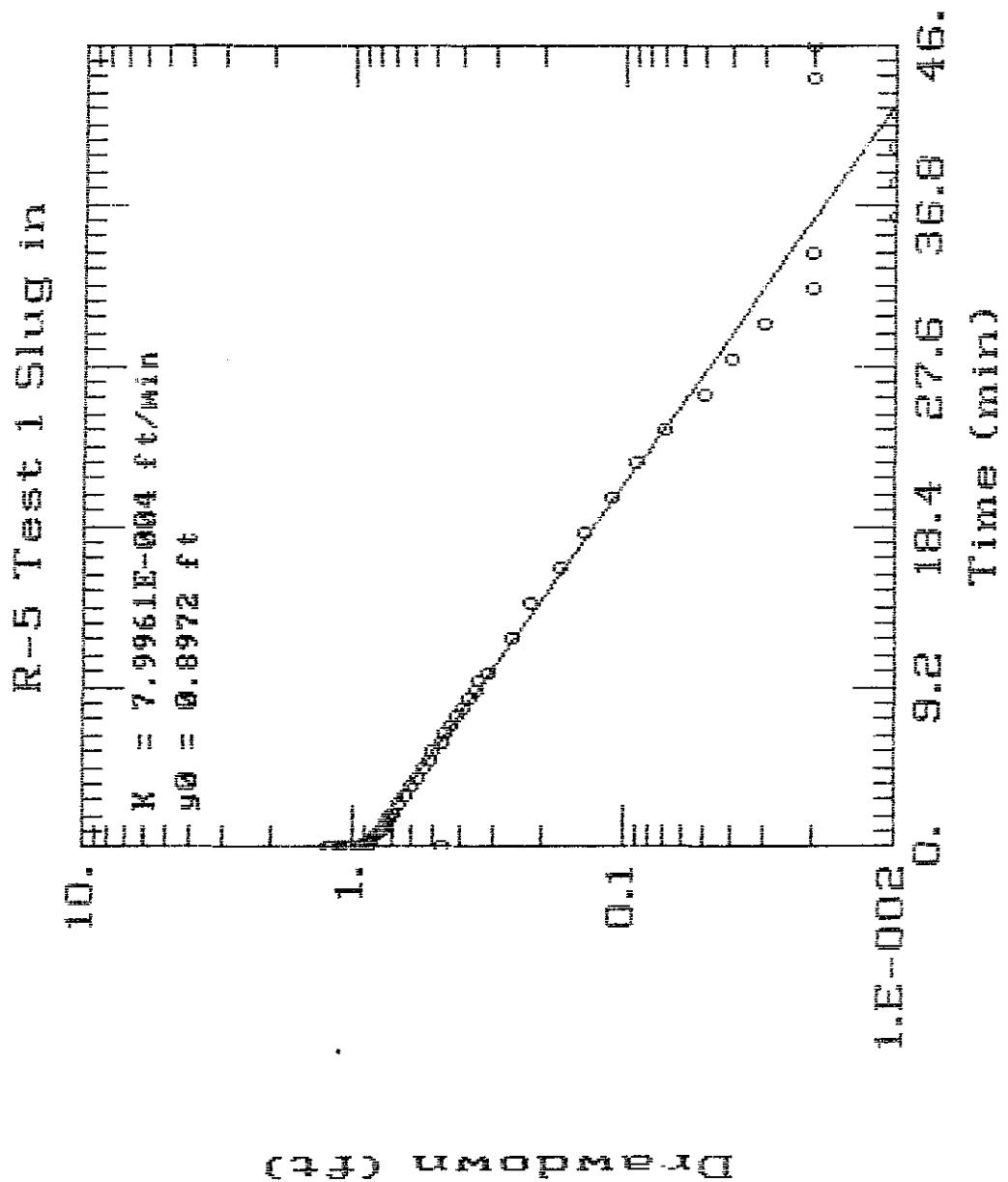
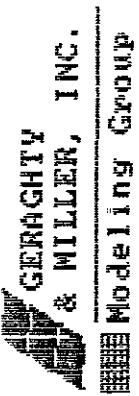
TIME (min⁻¹)

0.0 1.0 2.0 3.0 25.0 36.

00014

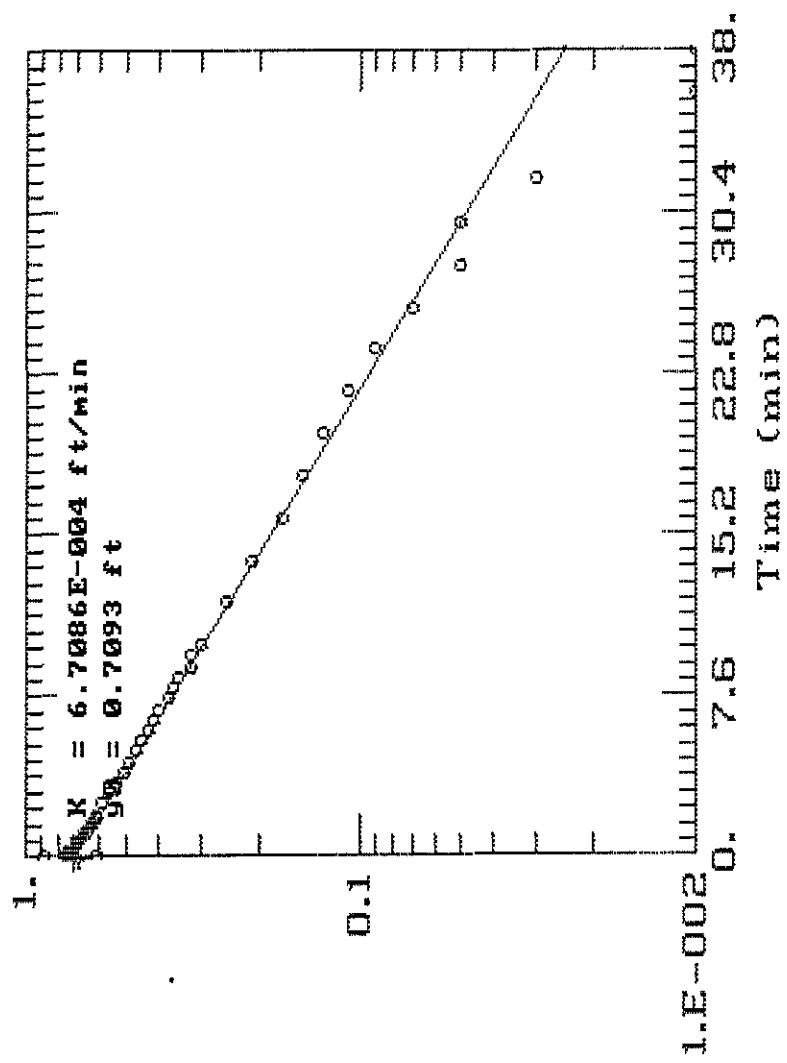
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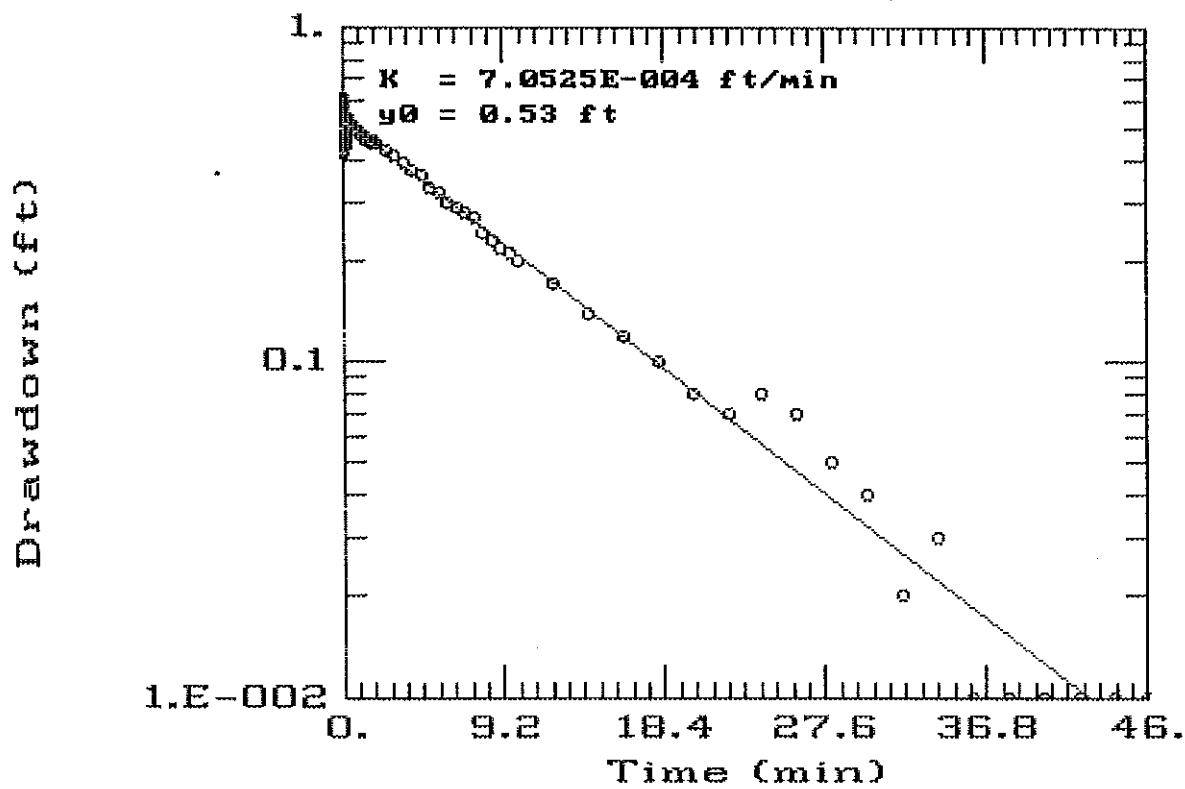
R-5 Test 2 Slug in



Drawdown (ft)

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R-5 Test 2 Slug out



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30
20
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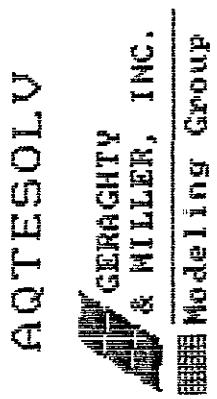
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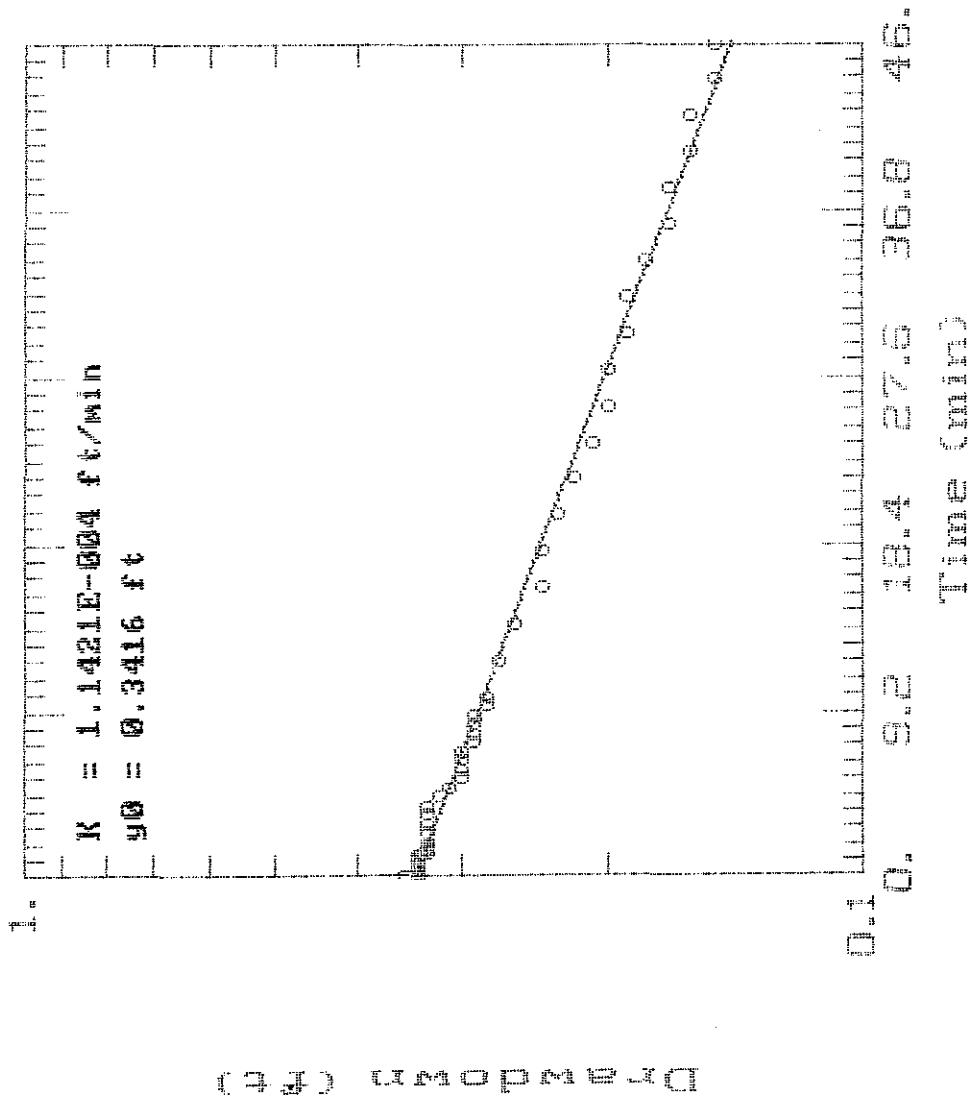
$$K = 6.824E-005 \text{ ft}^2/\text{min}$$

R-6 Test 1 Sliding Out

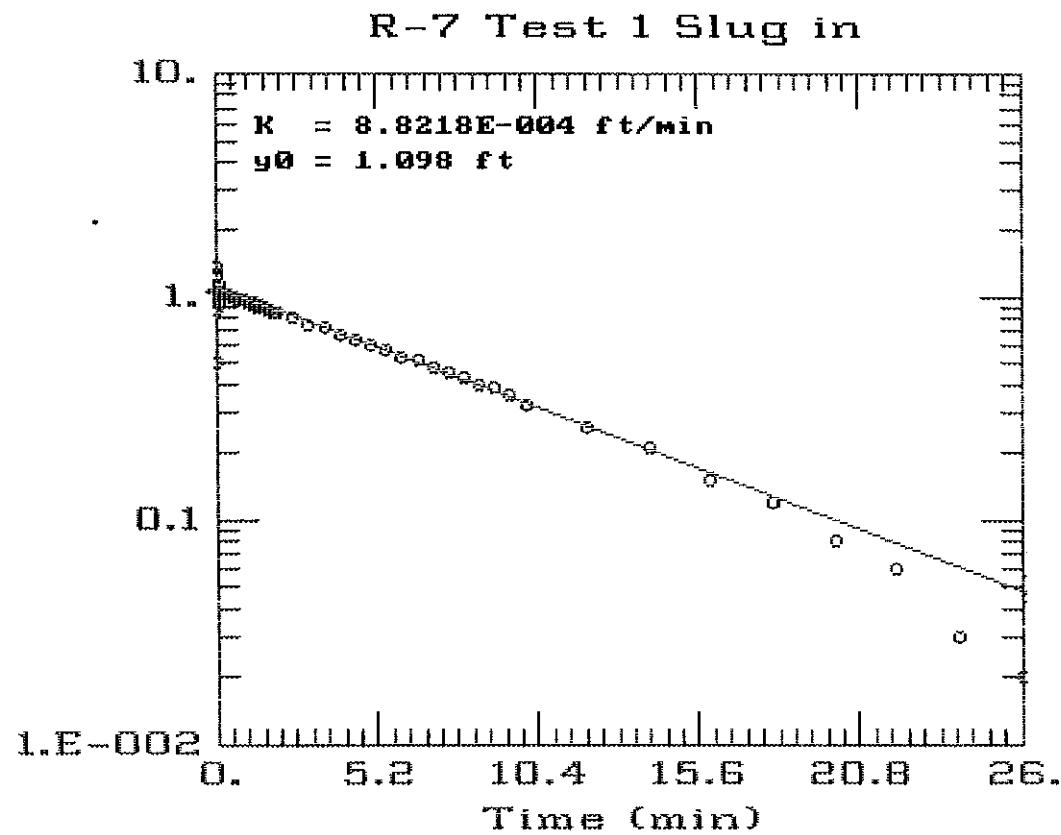
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R-6 Test 1 Slug in

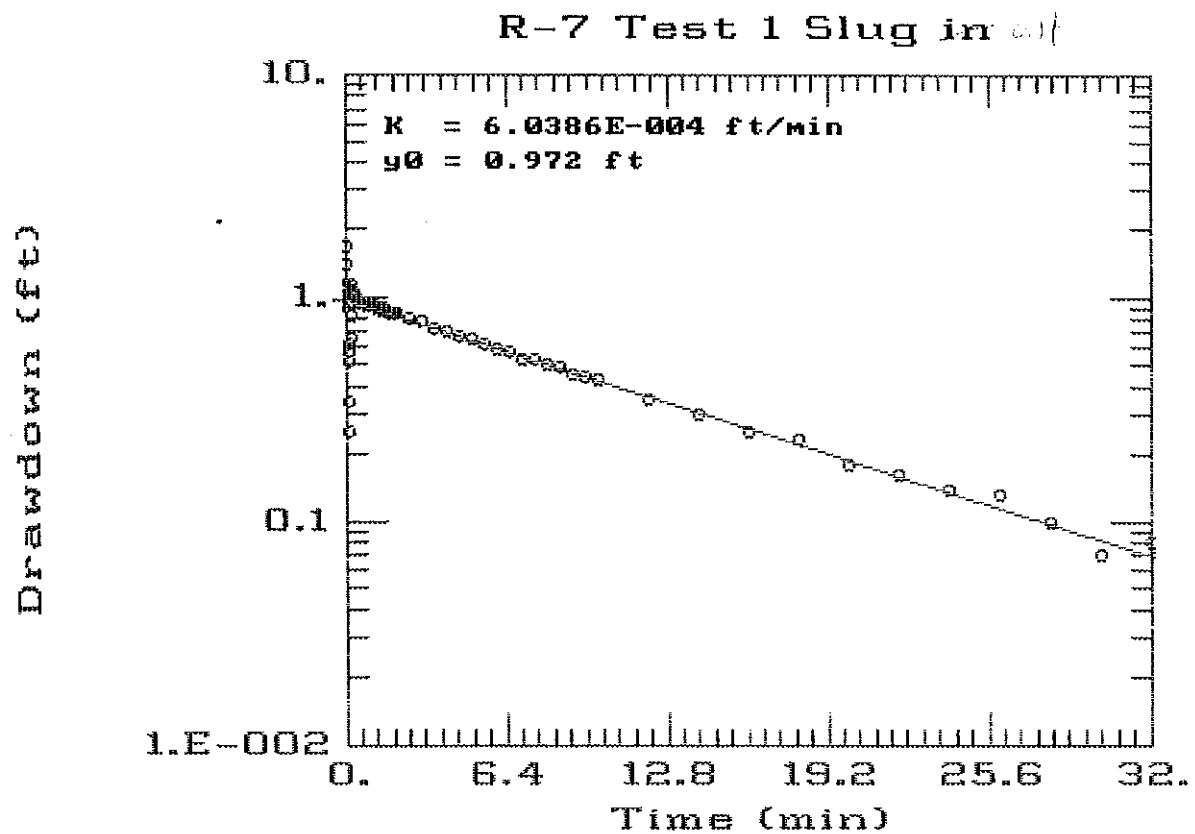


Drawdown (ft)



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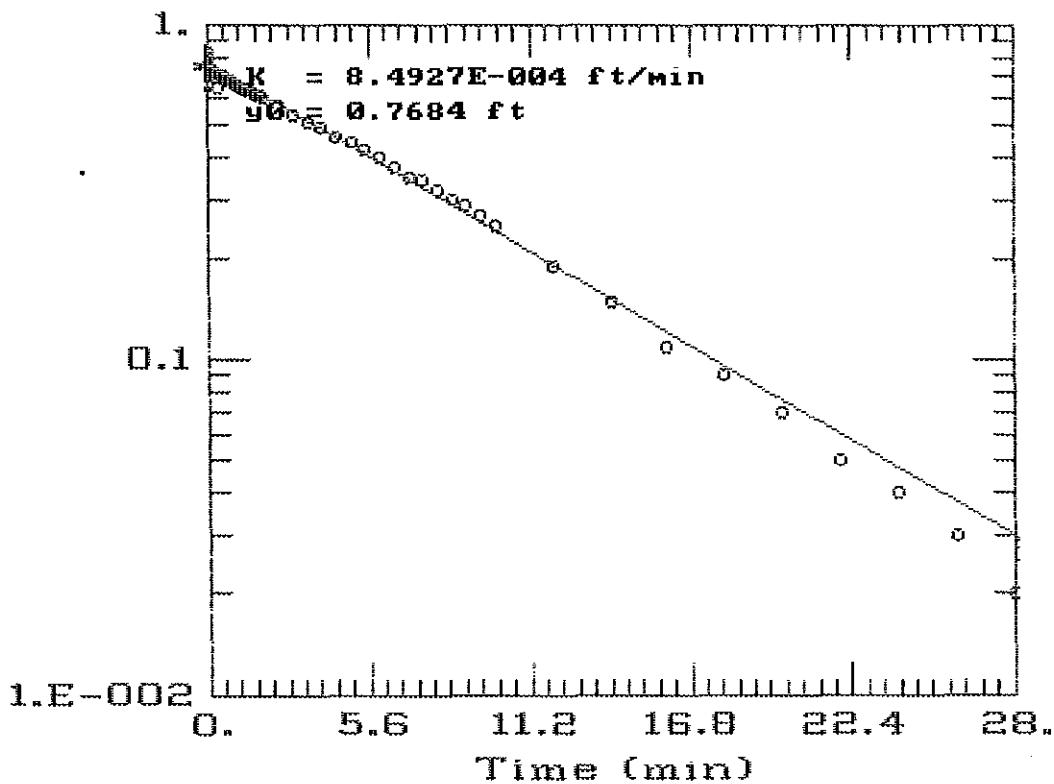


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Drawdown (ft)

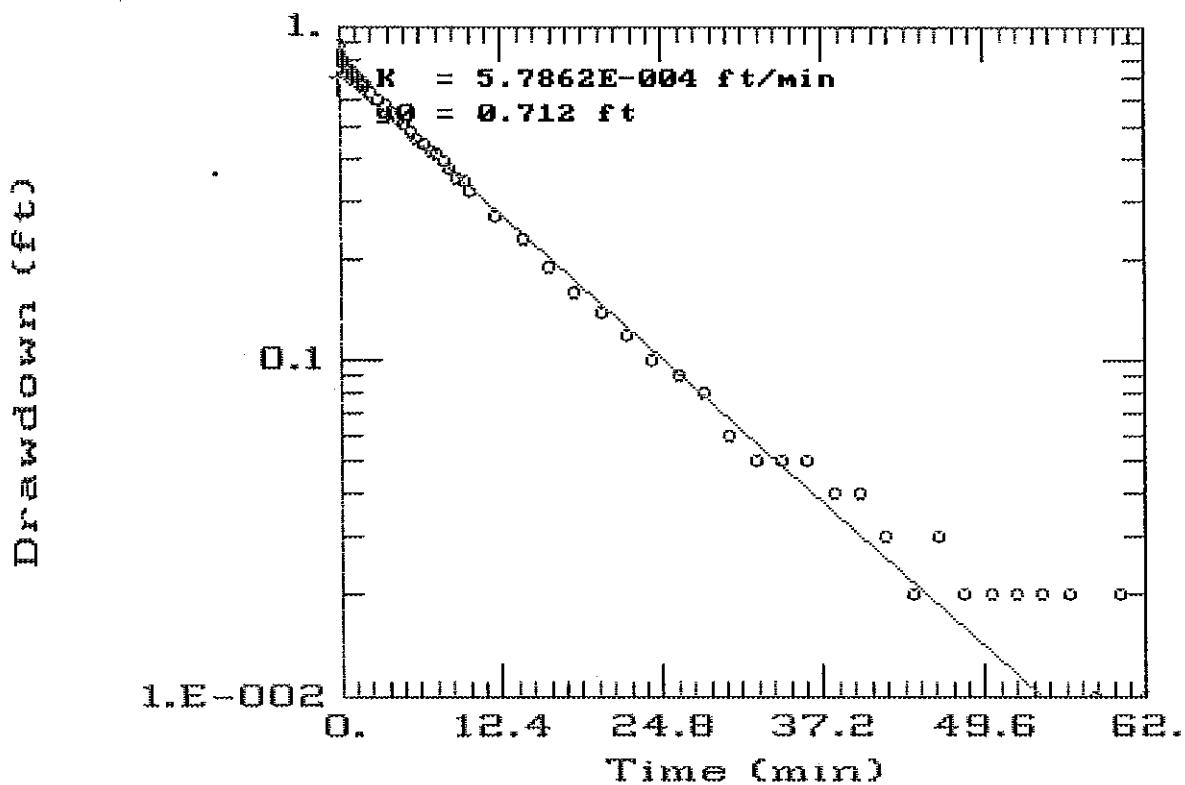
R-7 Test 2 Slug in



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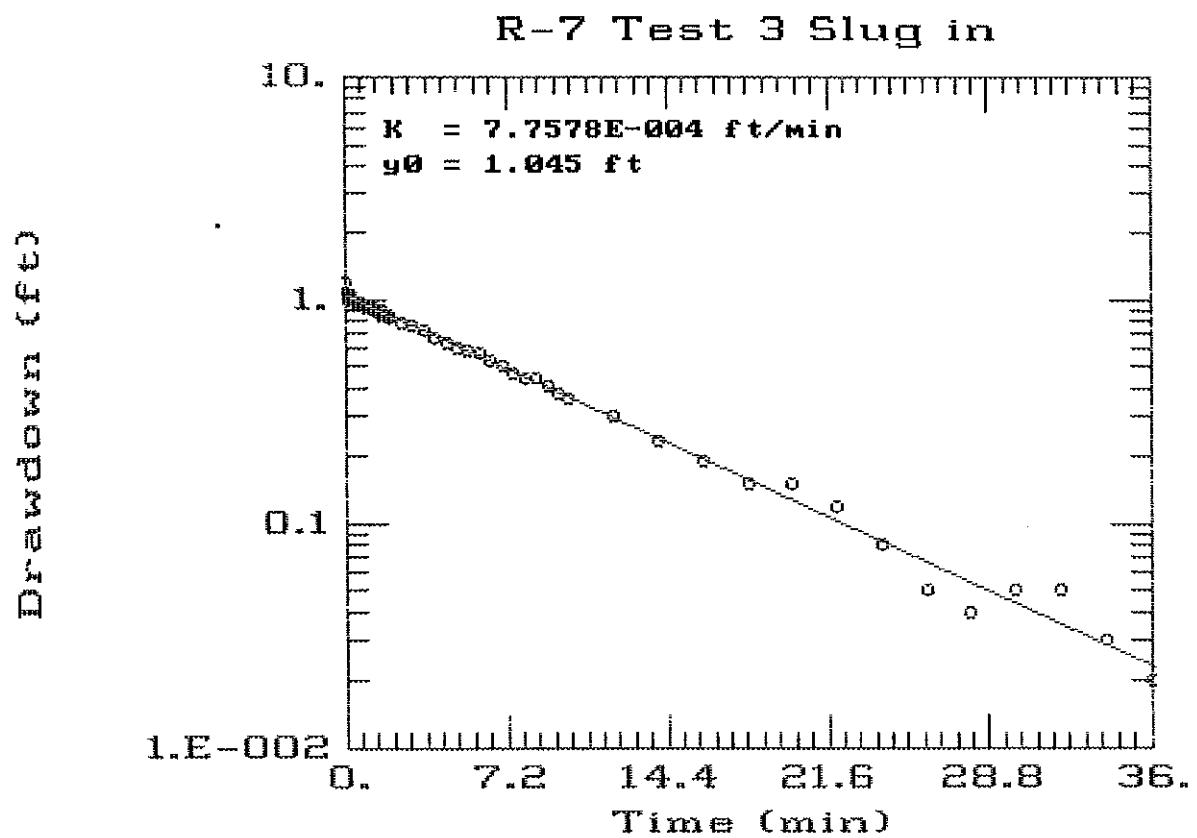
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R-7 Test 2 Slug out



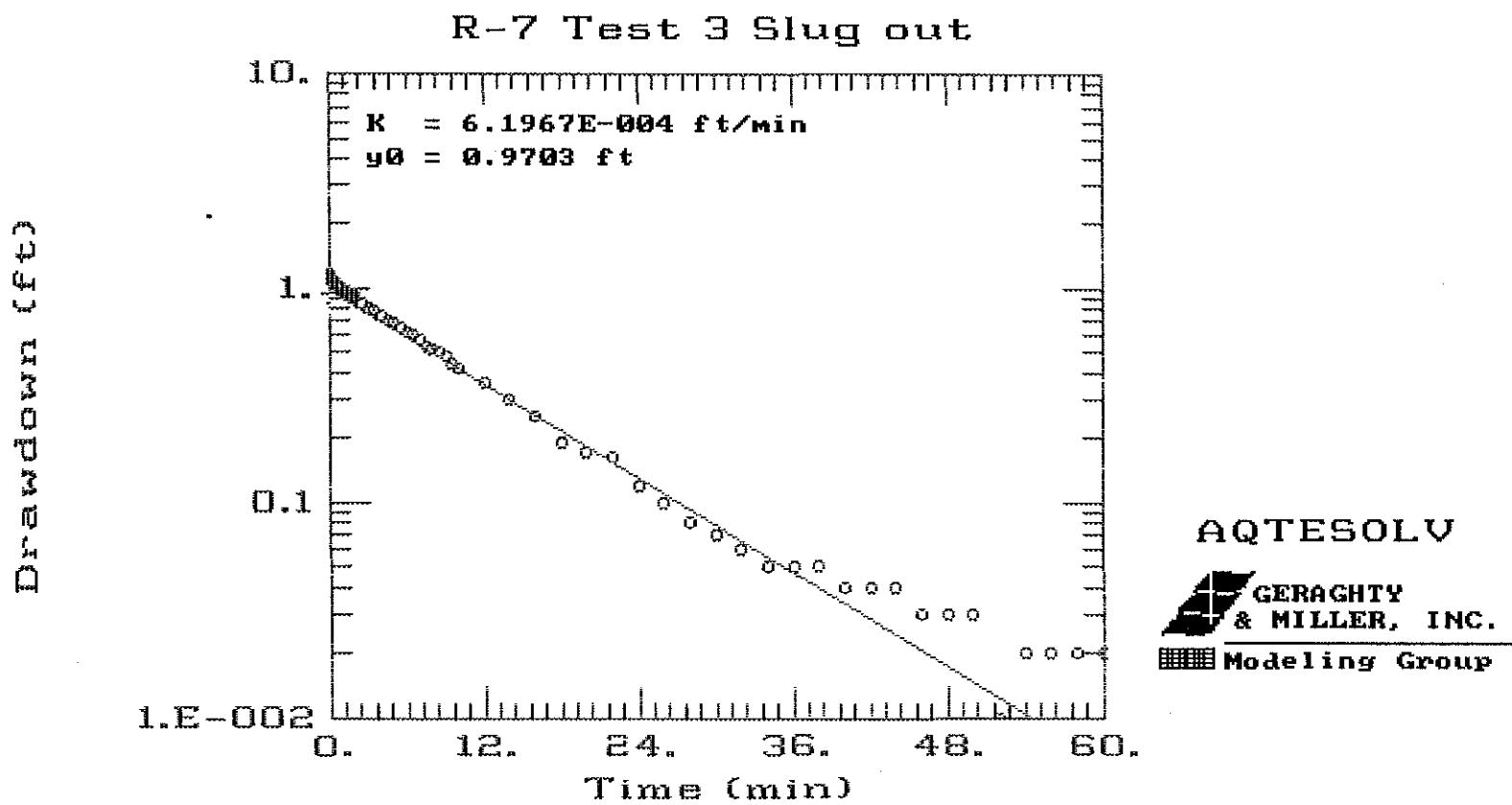
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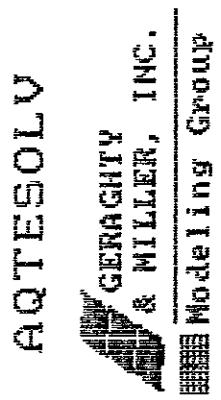
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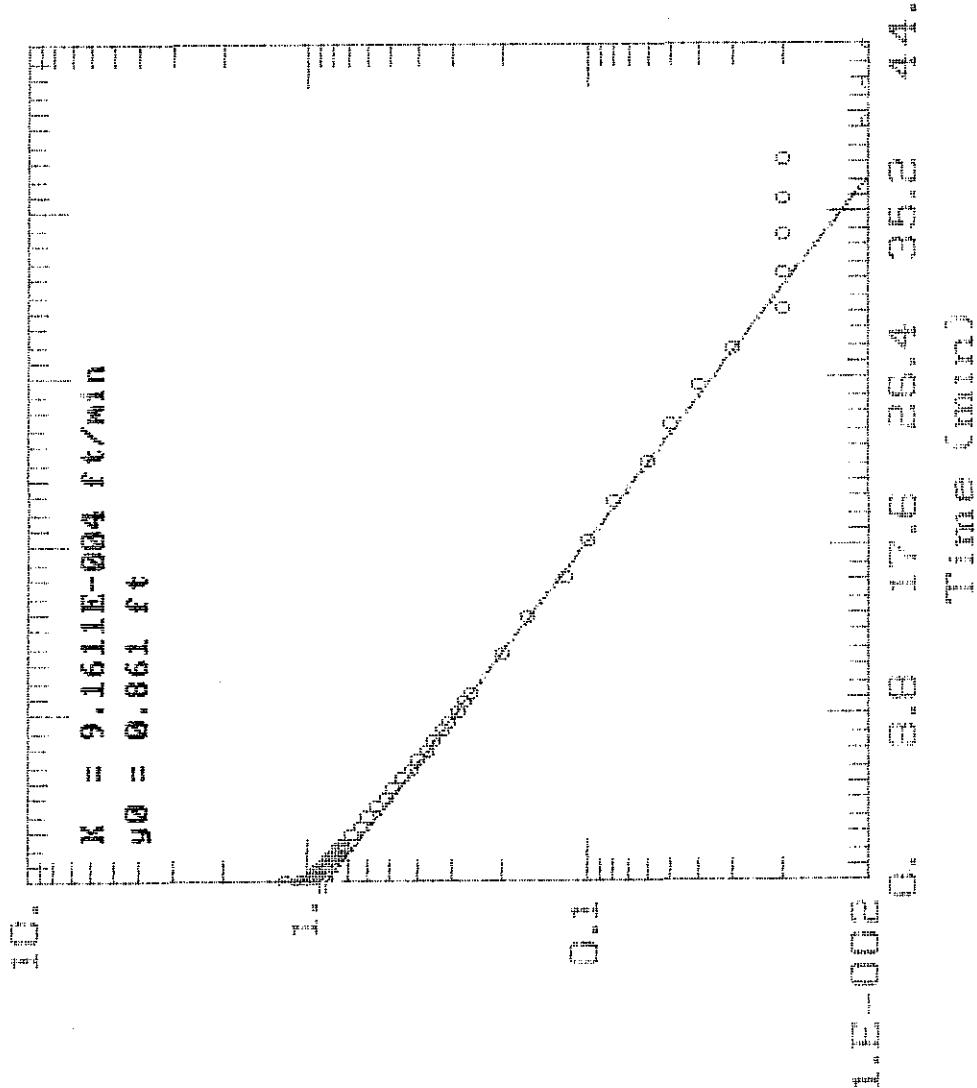


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R-8 Test 1 Slung in



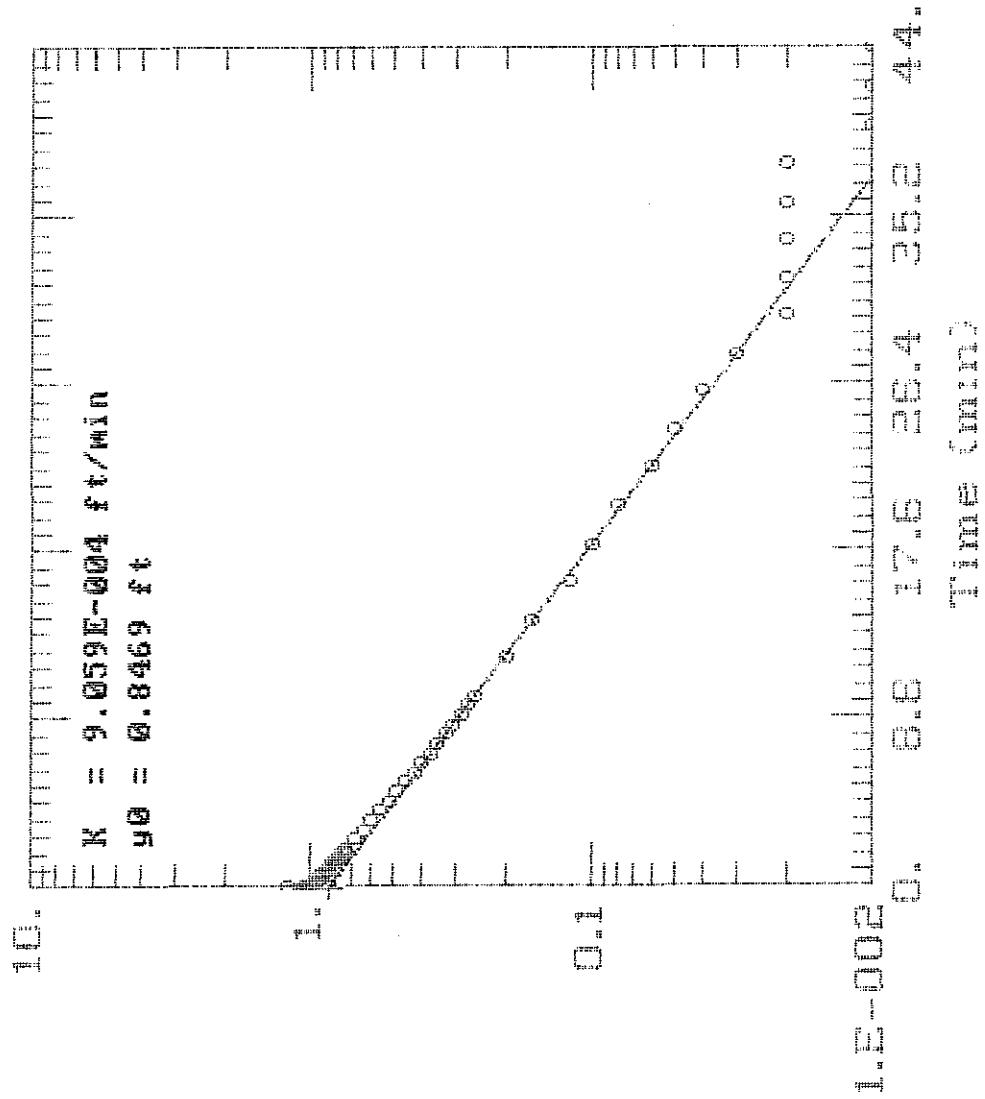
DATA FROM CLOUD C44

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Medieval English

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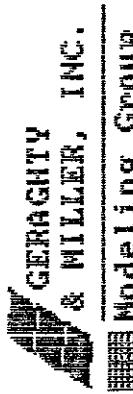
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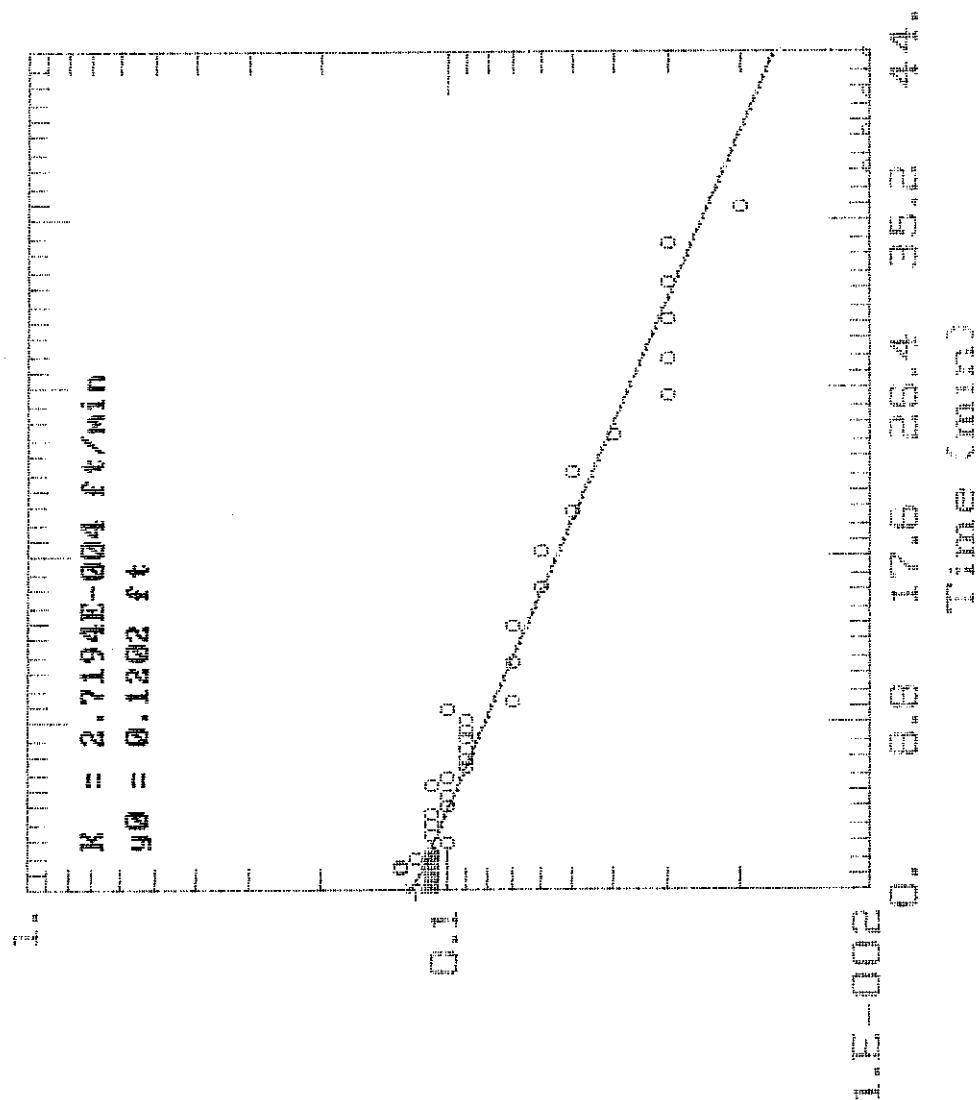
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WORLDS IN CHAOS



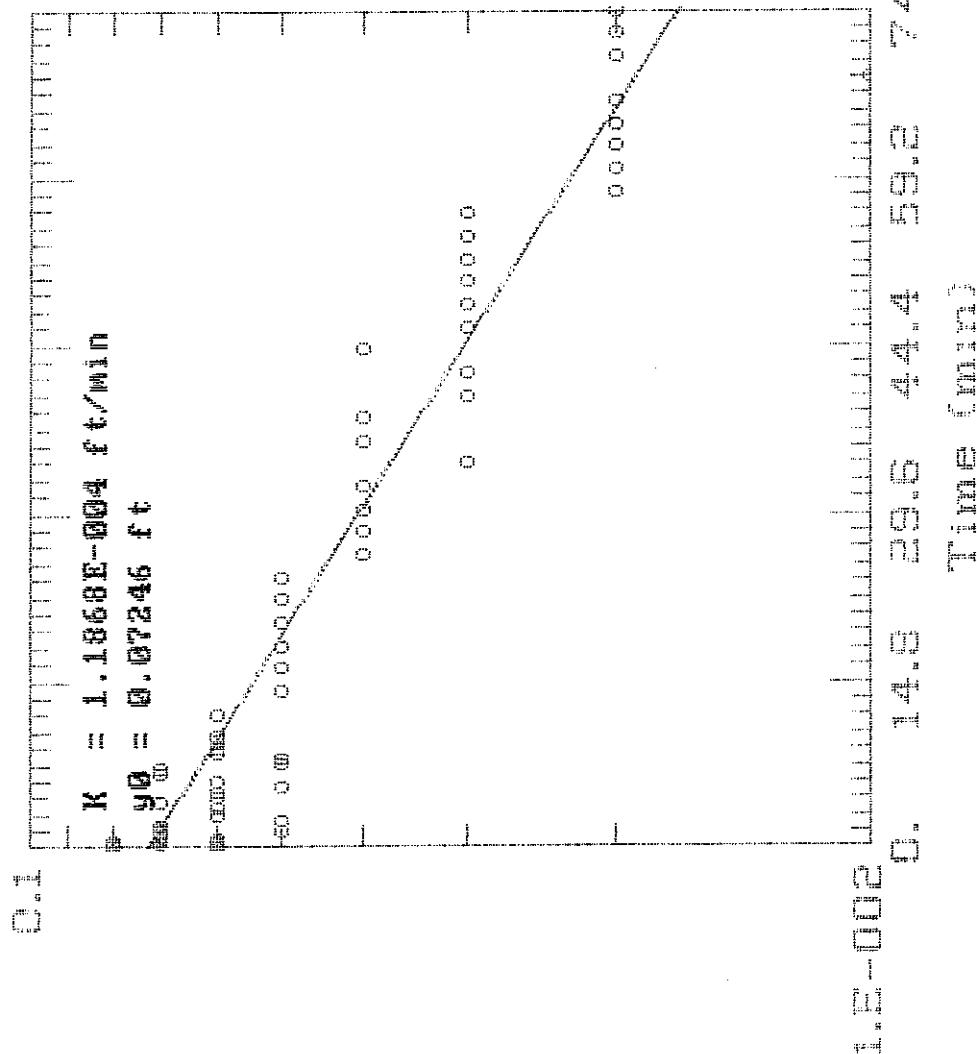
IR-B Test 1 Slides in

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$$K = 2 \cdot 71941 - 0.2$$

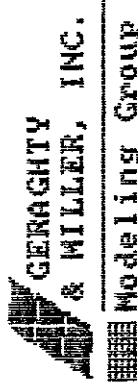
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R-9 Test 1 Slug out

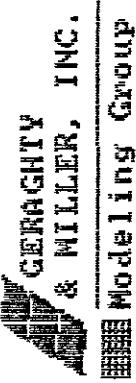


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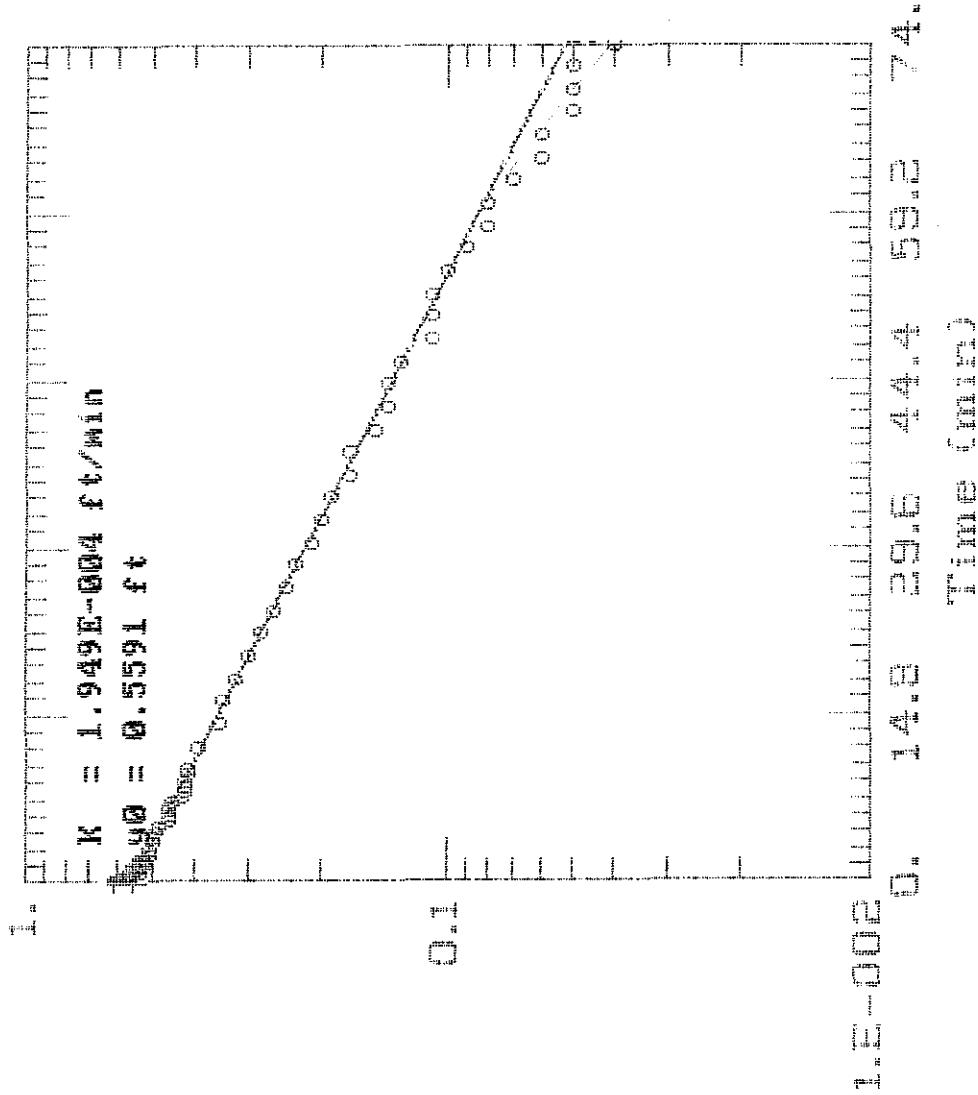


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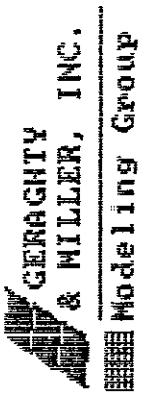
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R-10 Test 1 Slug out



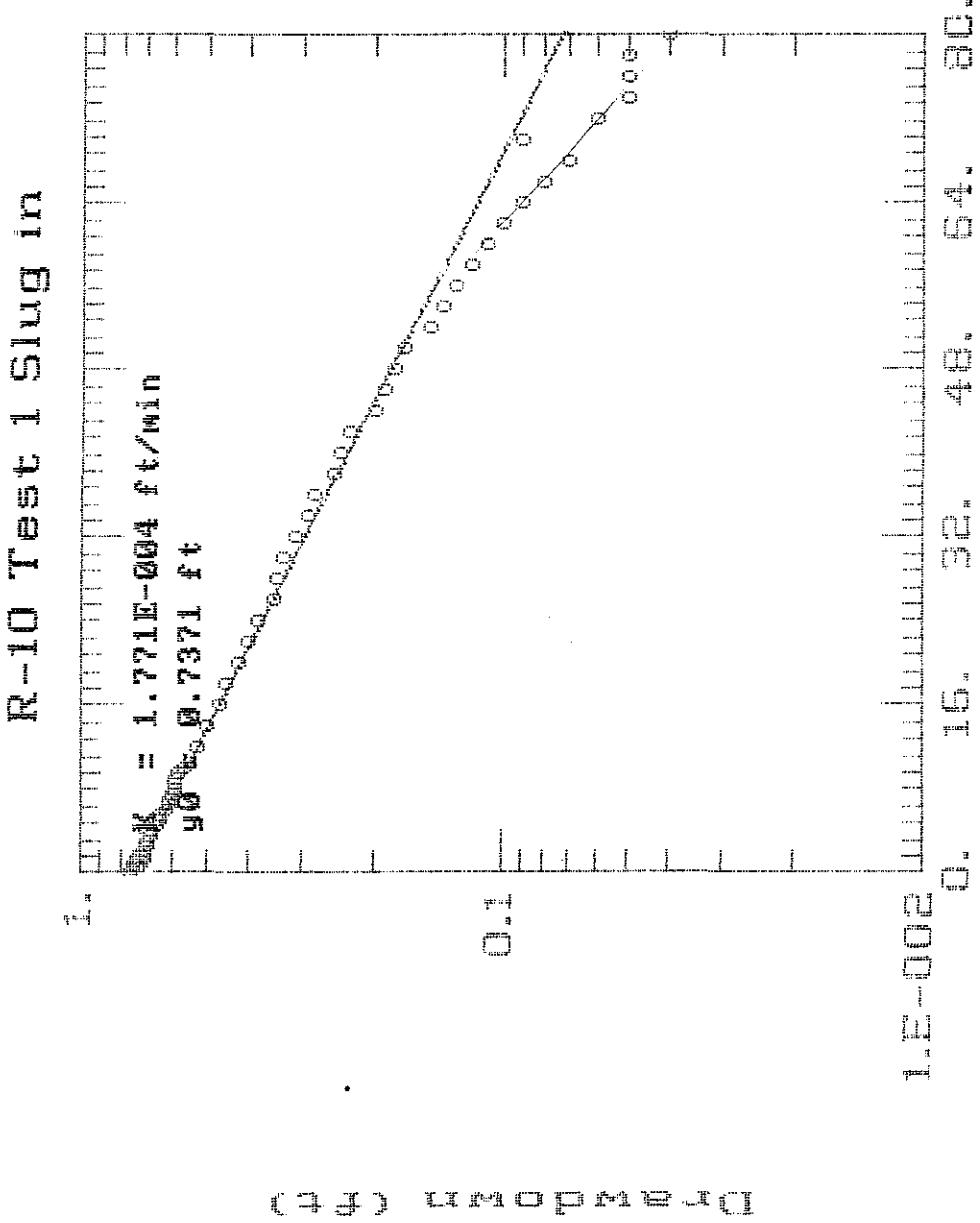
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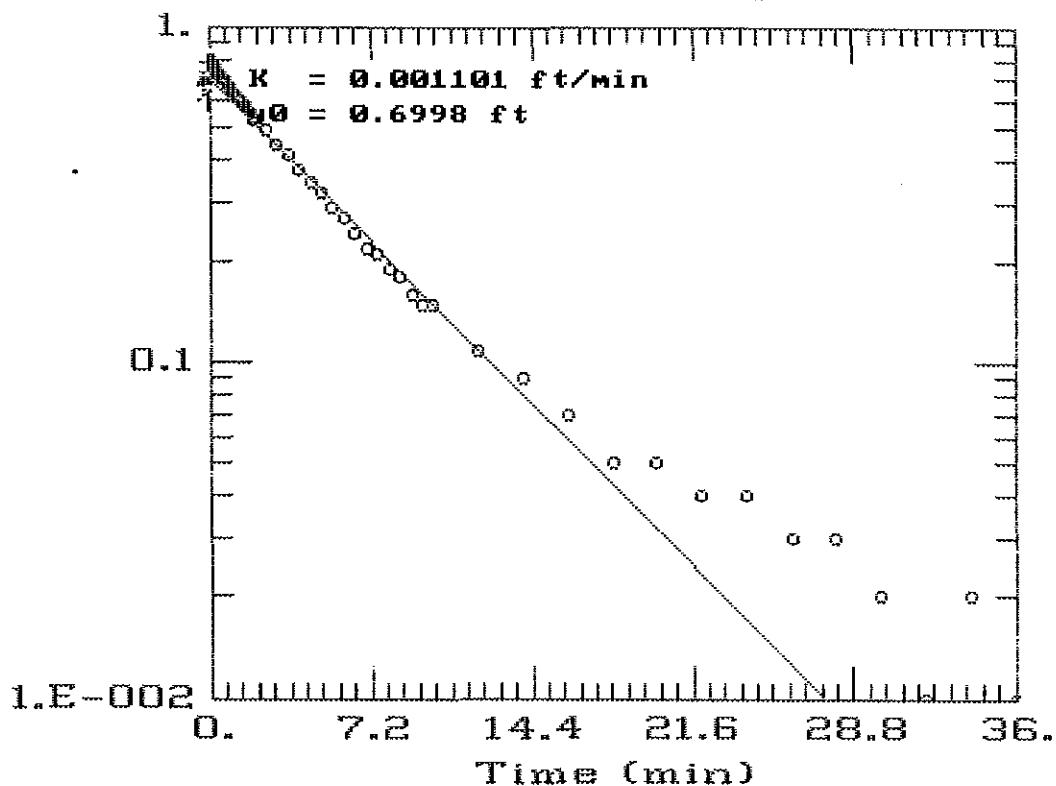
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Drawdown (ft)

R-11 Test 1 Slug out

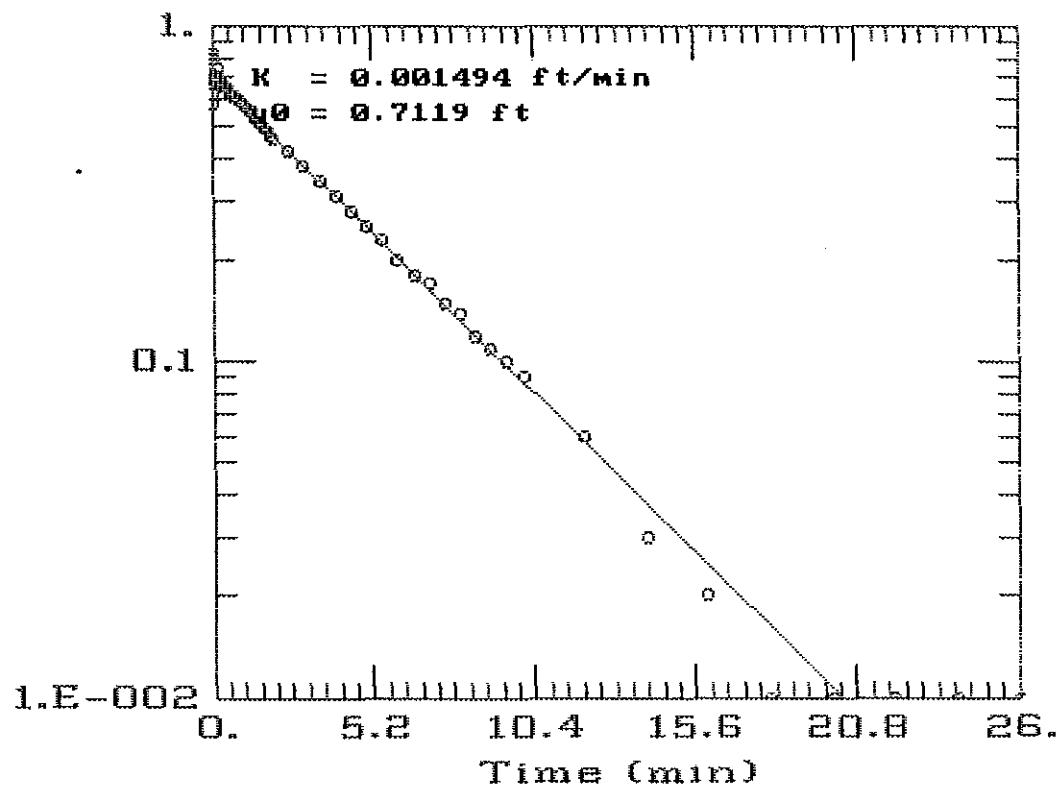


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Modeling Group

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Drawdown (ft)

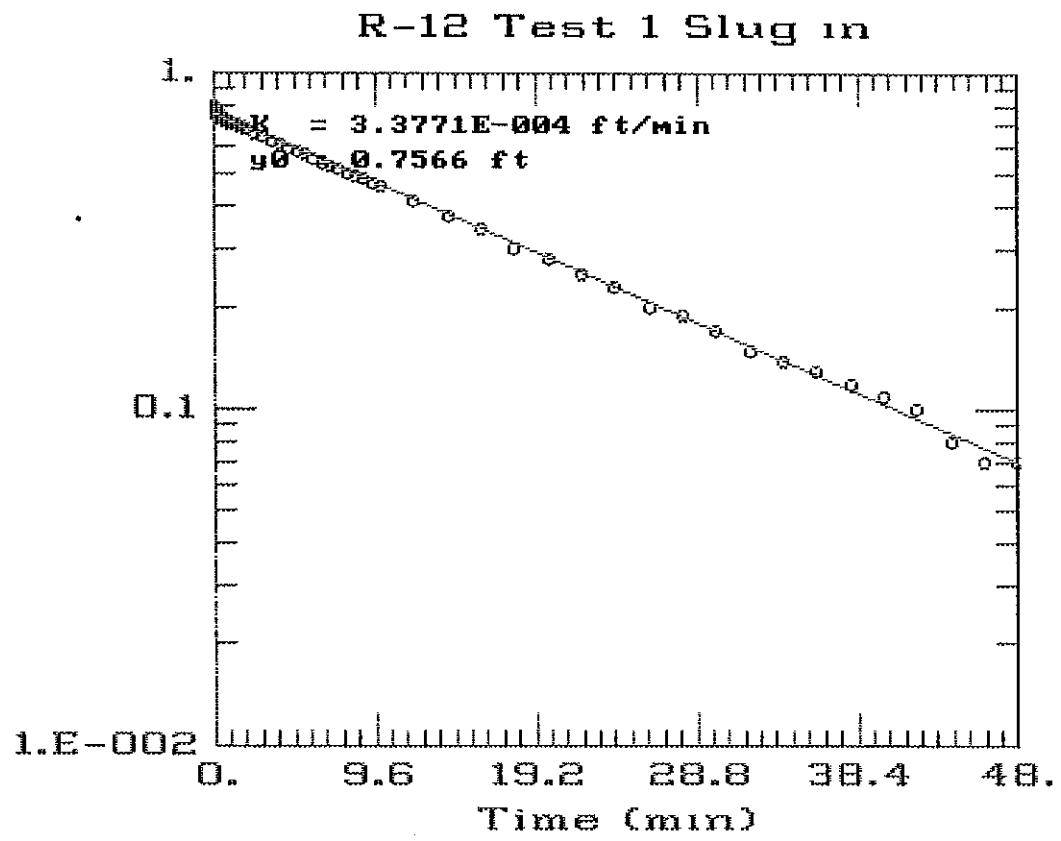
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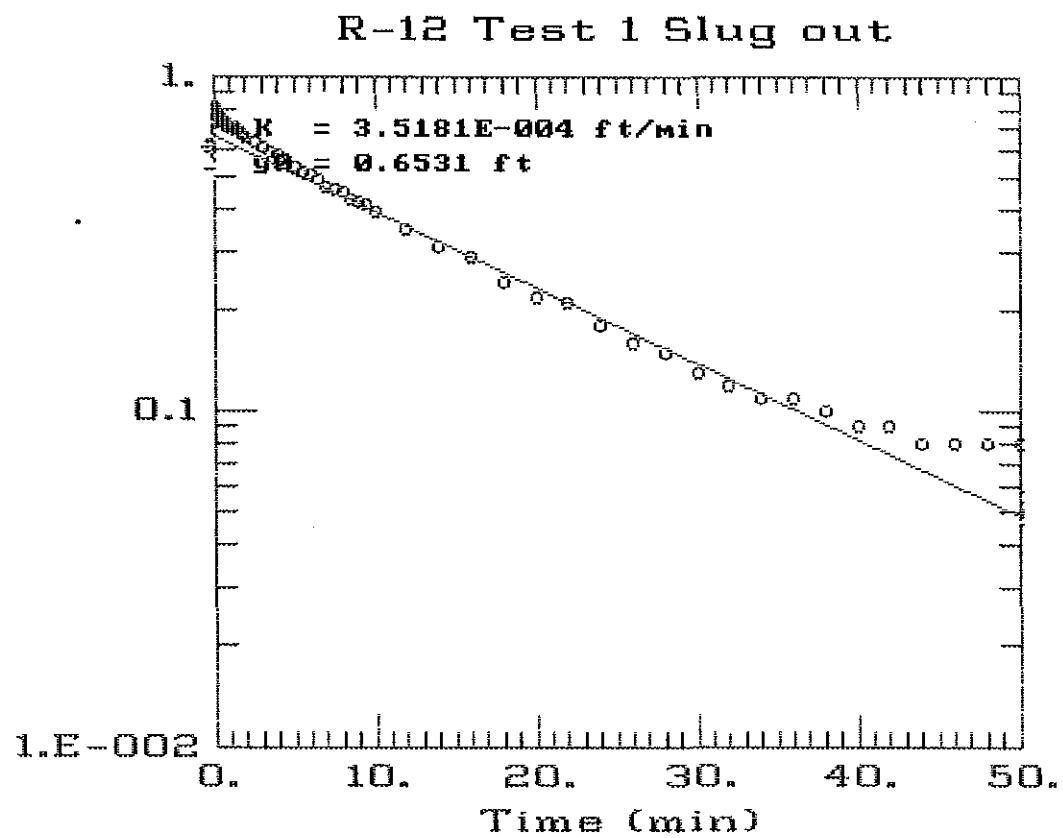
Drawdown (ft)



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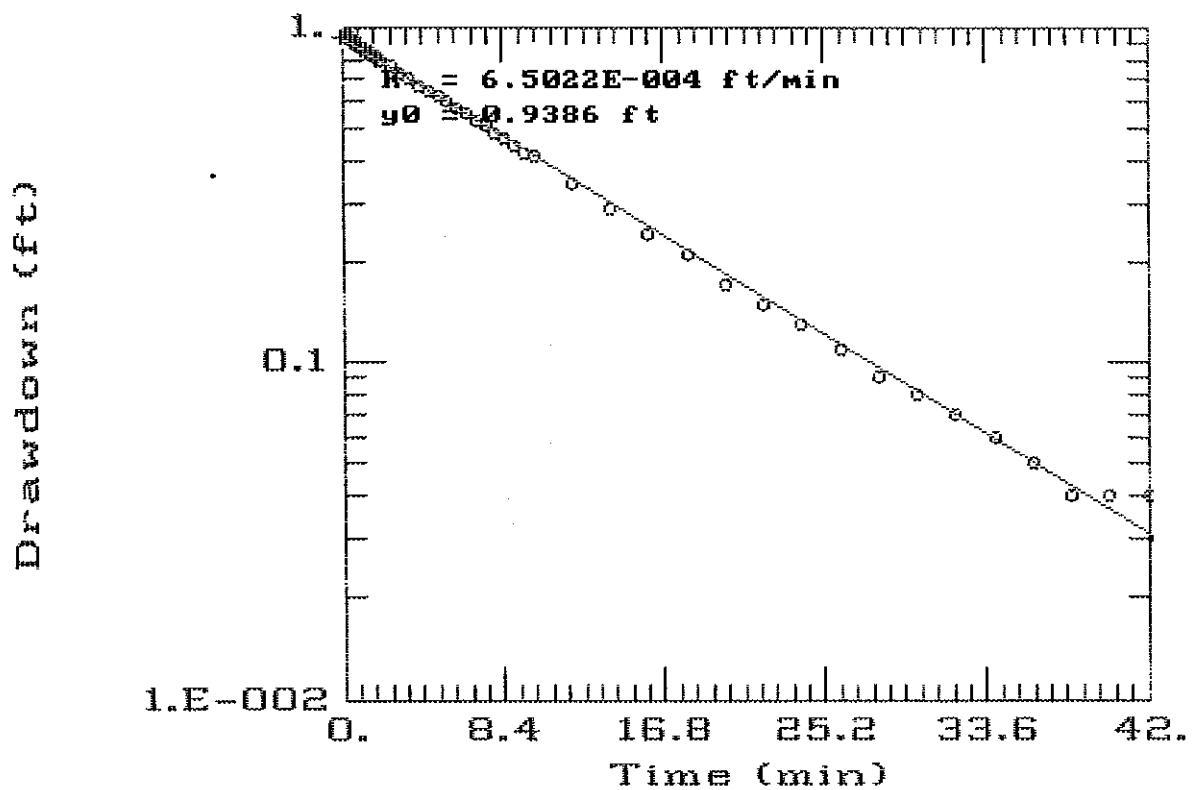
Drawdown (ft)



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Modeling Group

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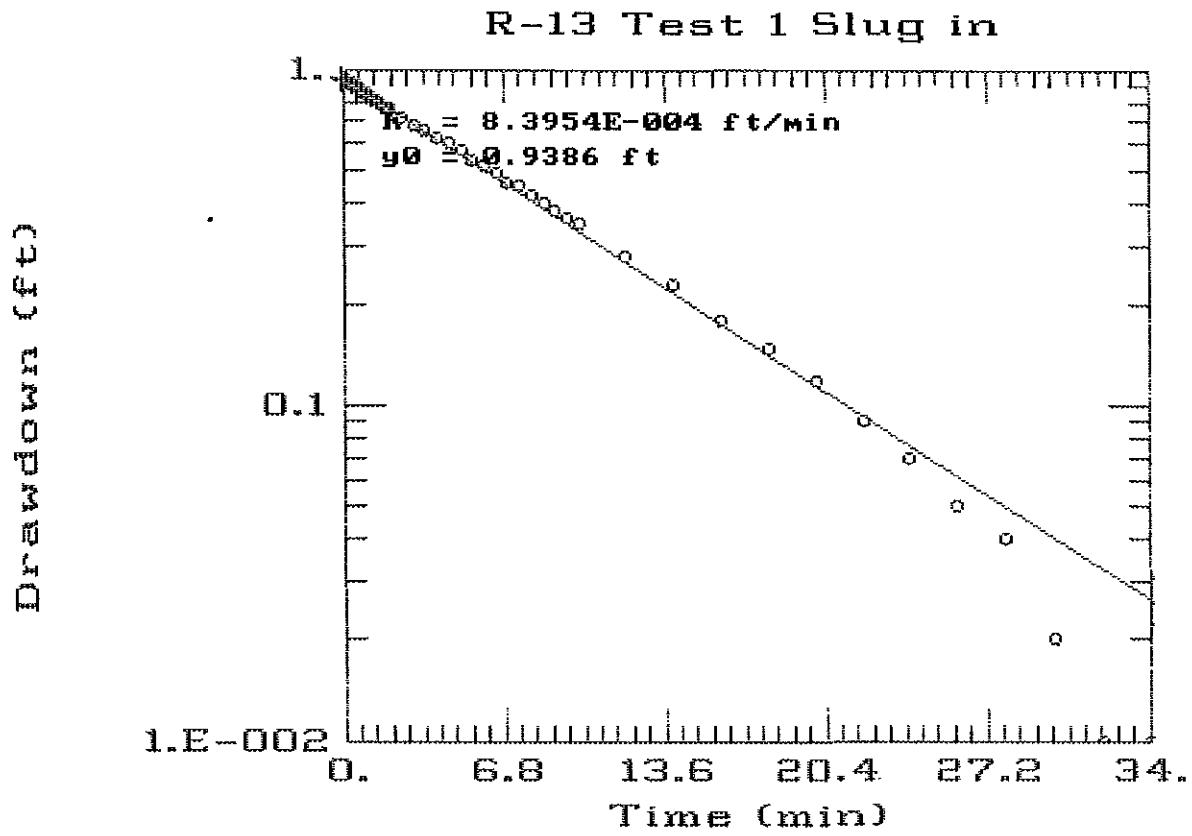
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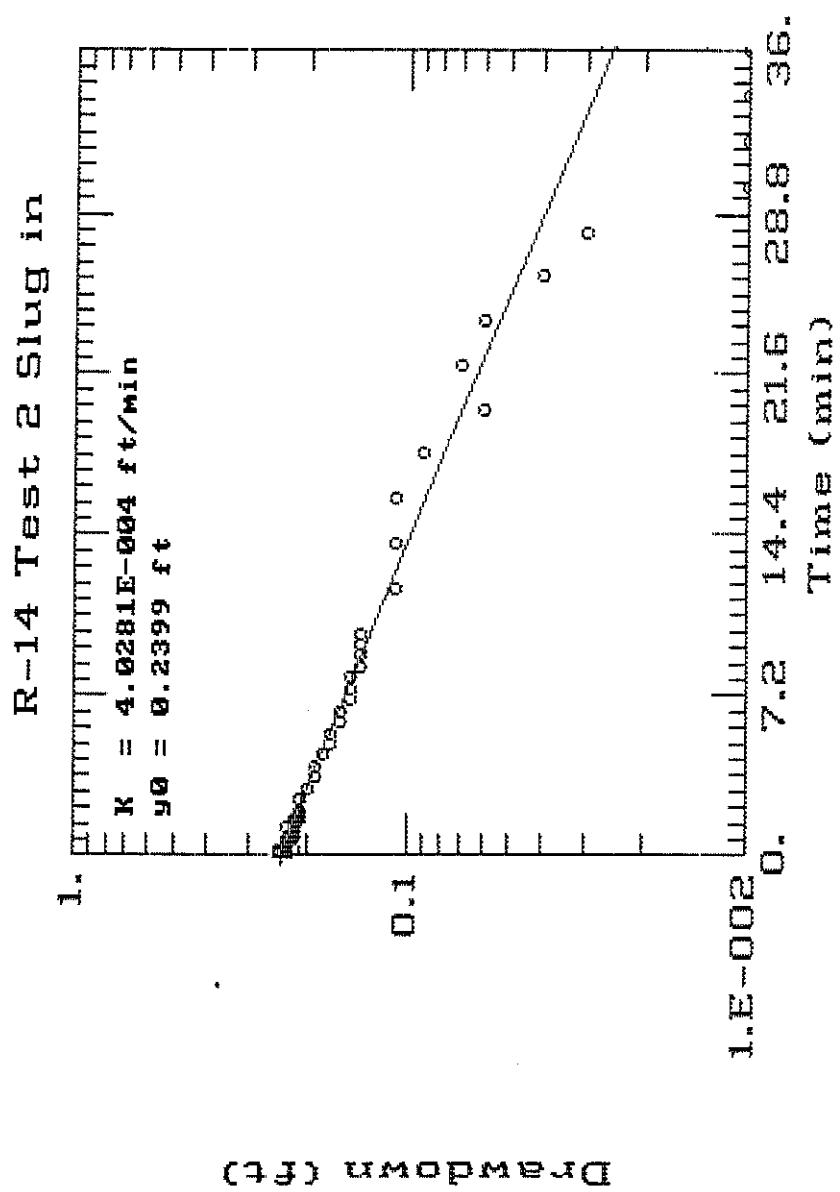
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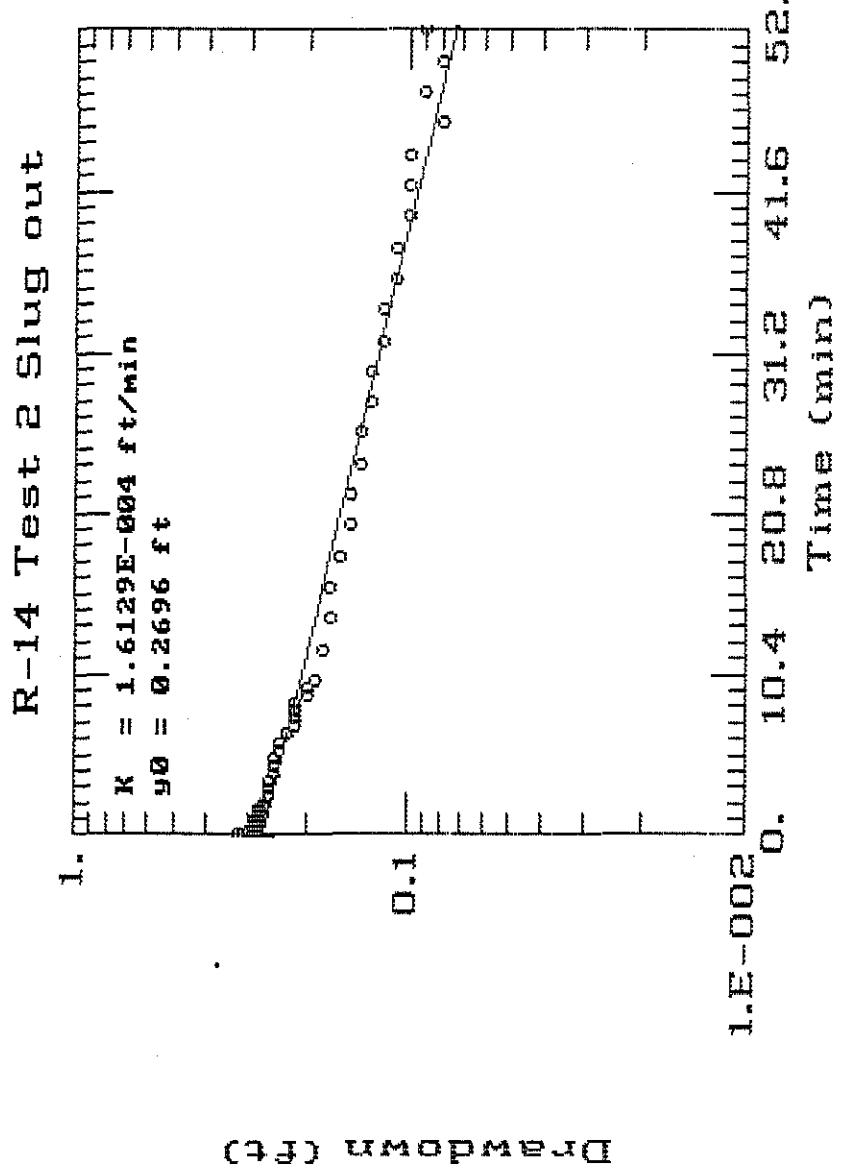
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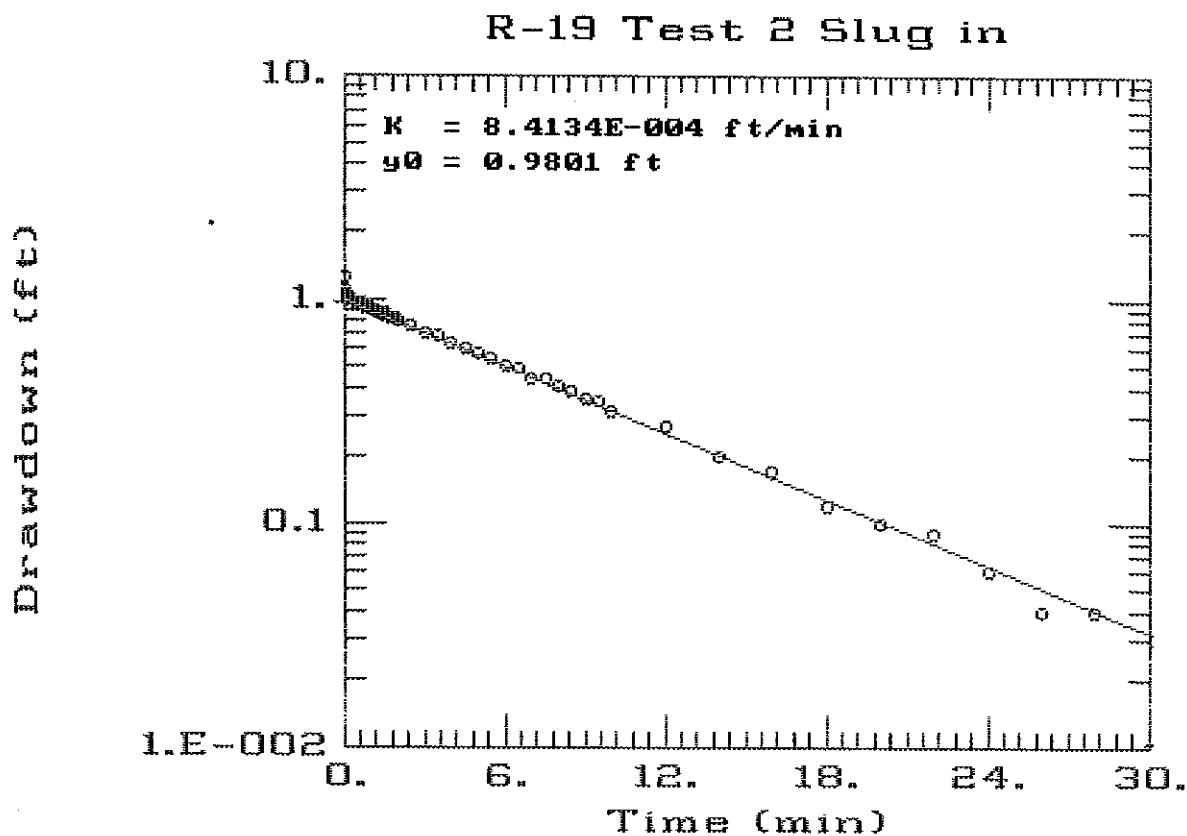
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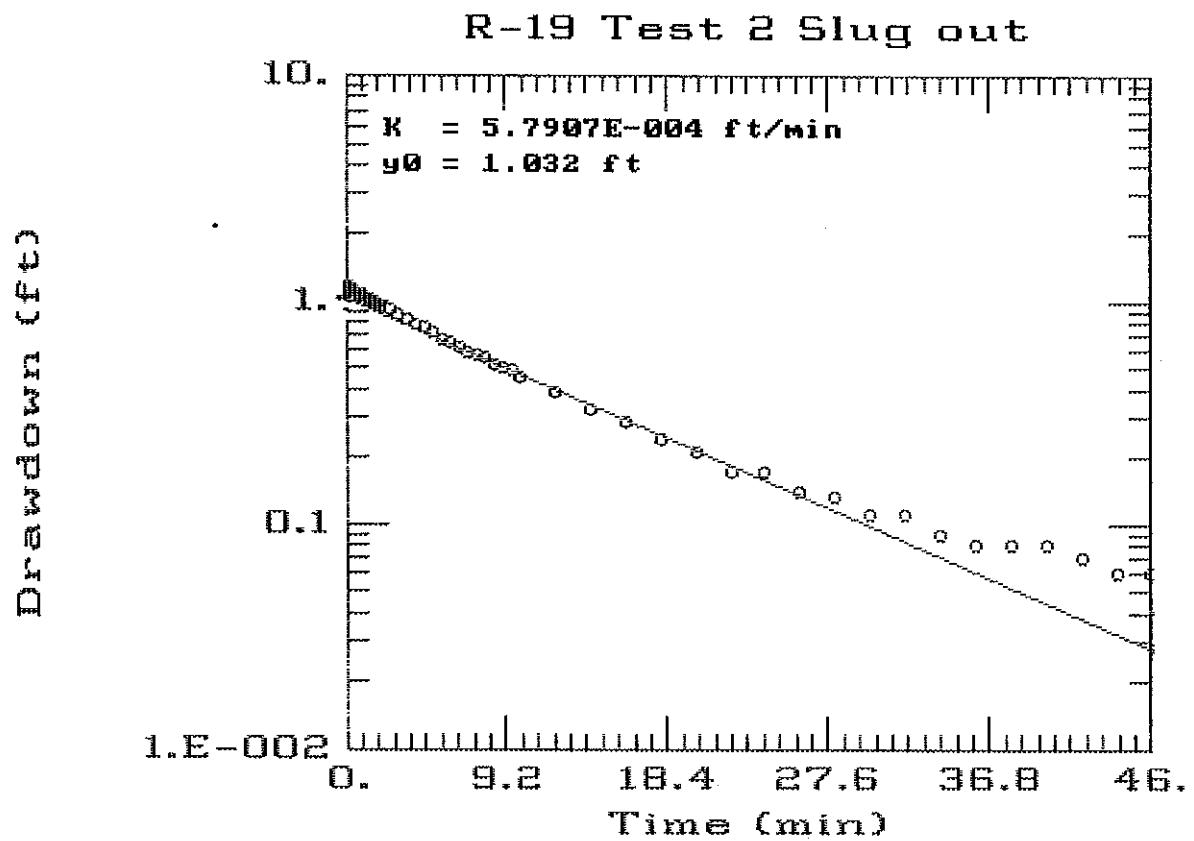
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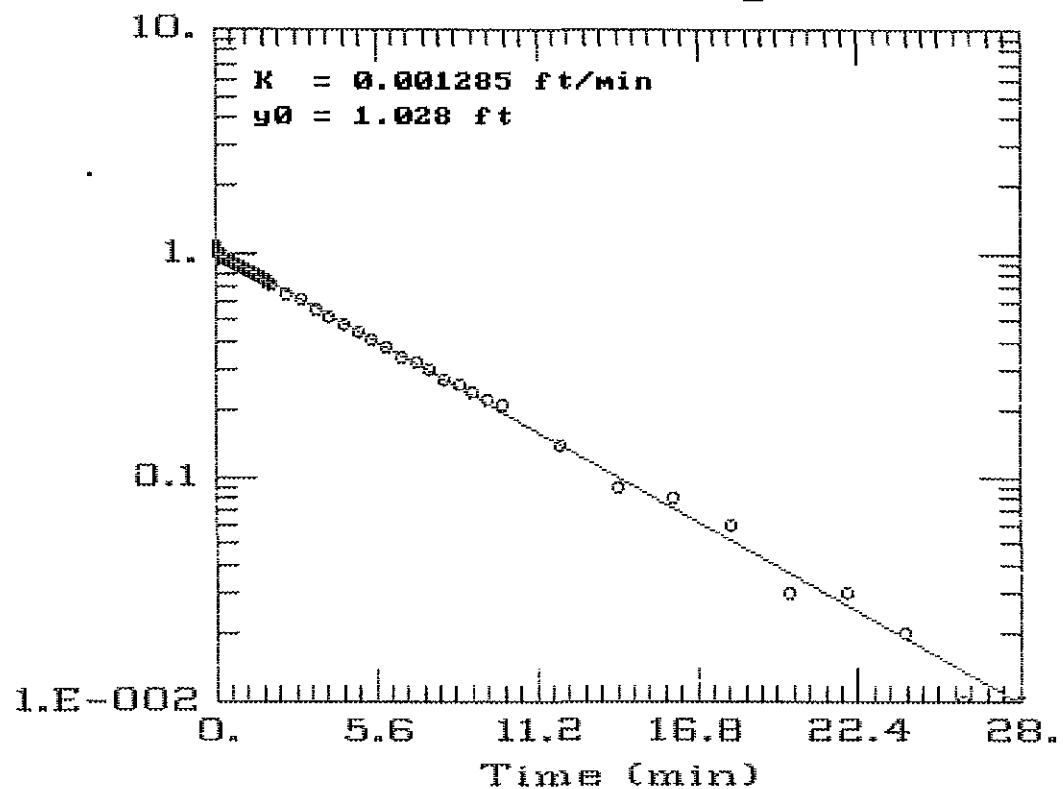


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Drawdown (ft)

R15 Test 5 Slug out

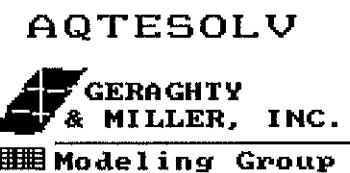
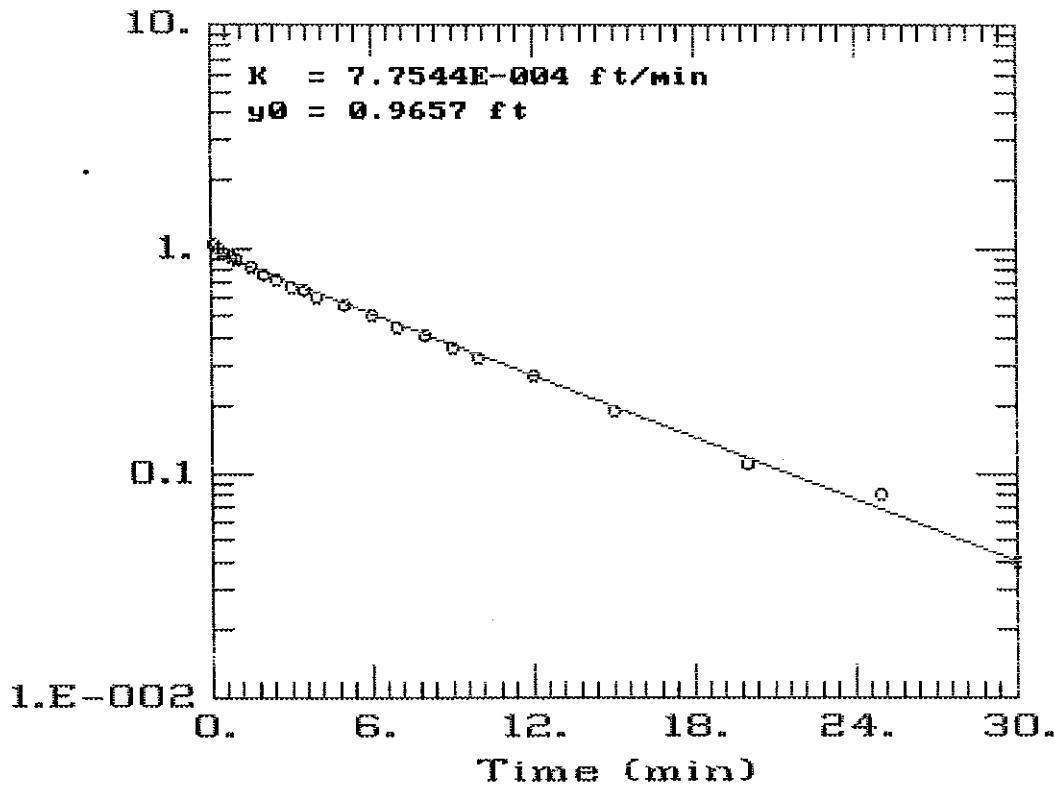


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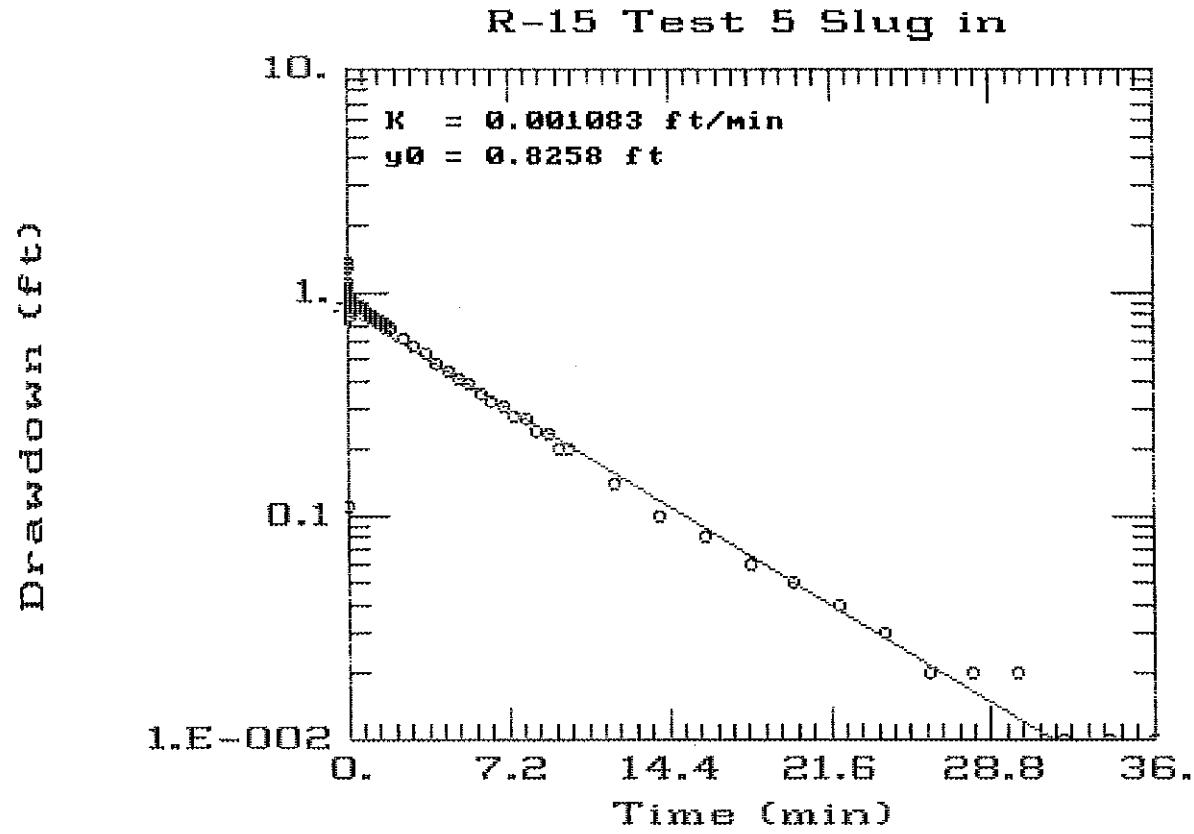
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Drawdown (ft)

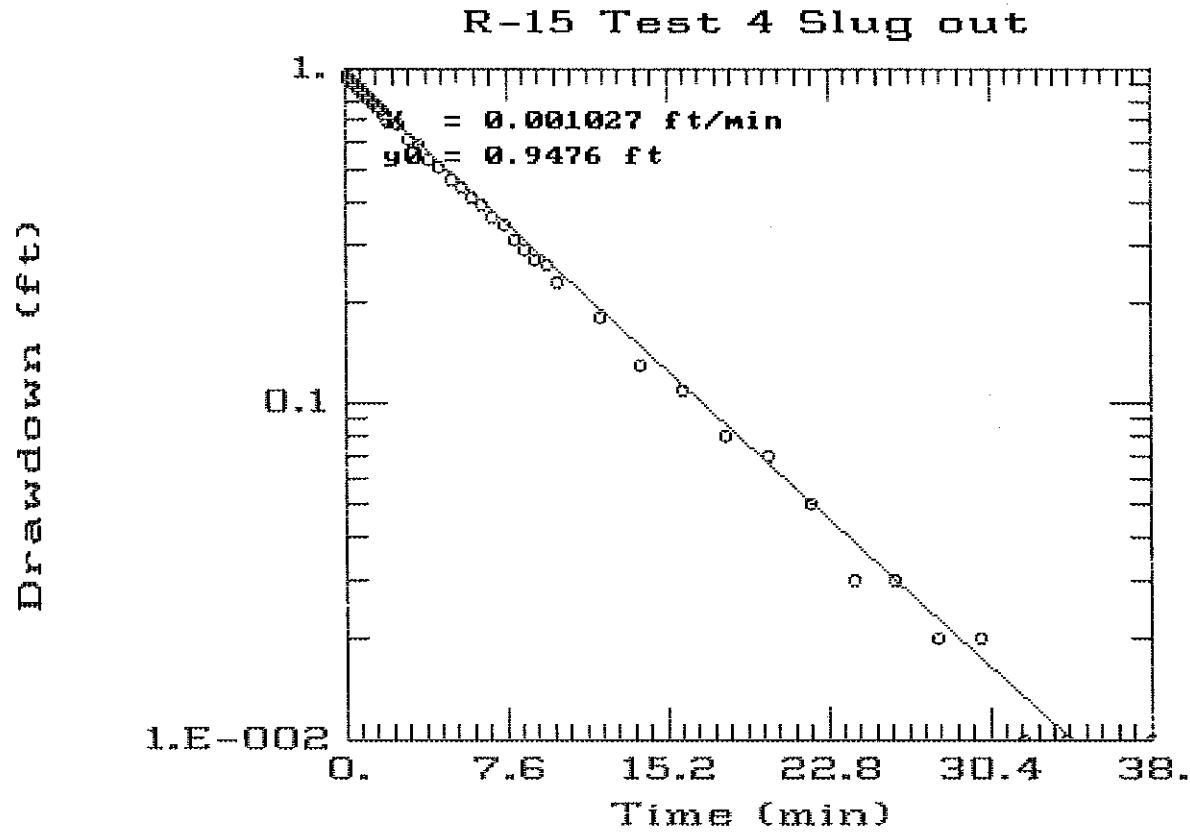
R-19 Test 3 Slug in (manual)



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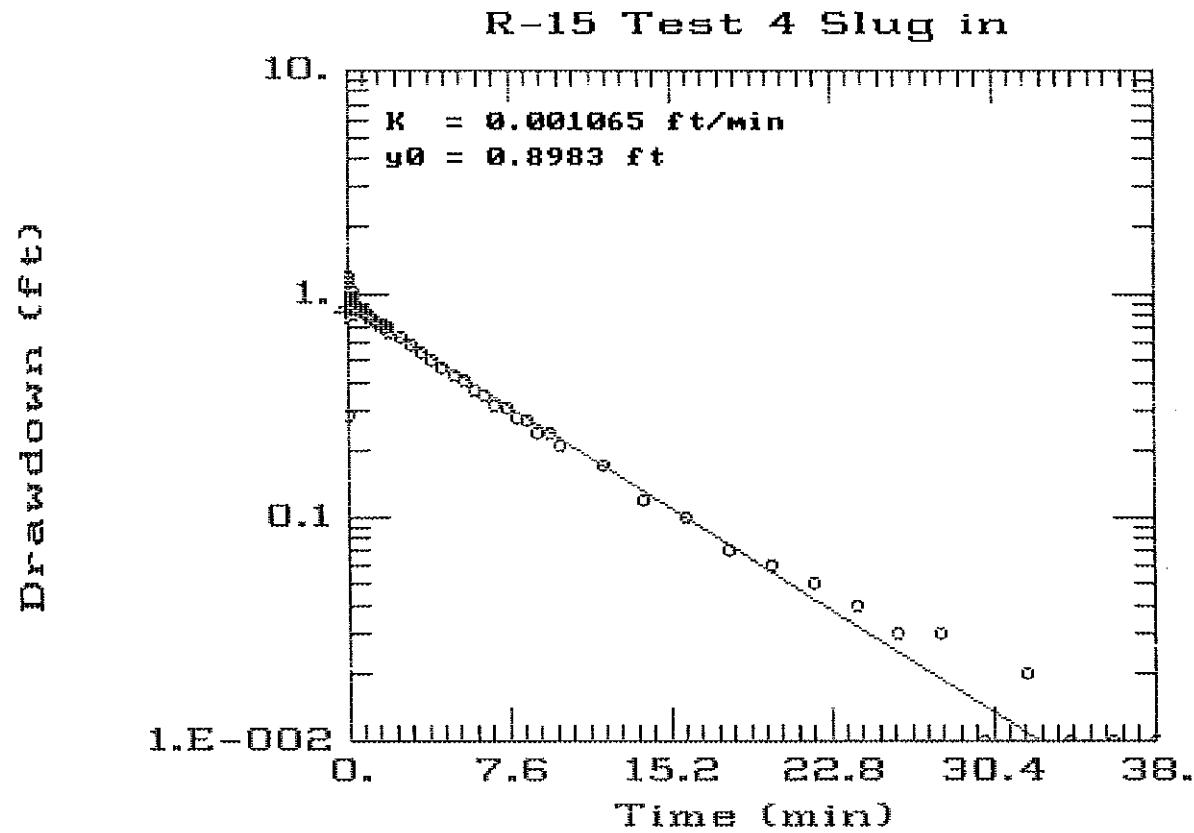


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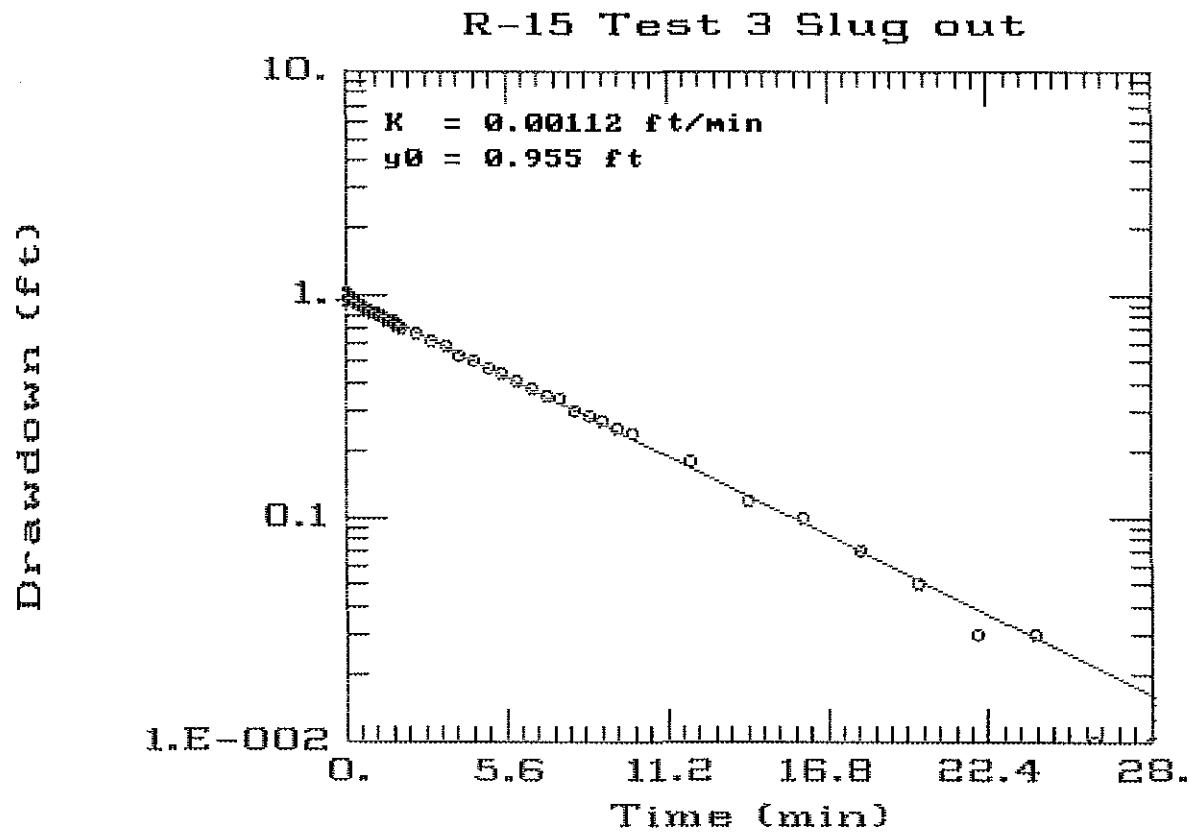
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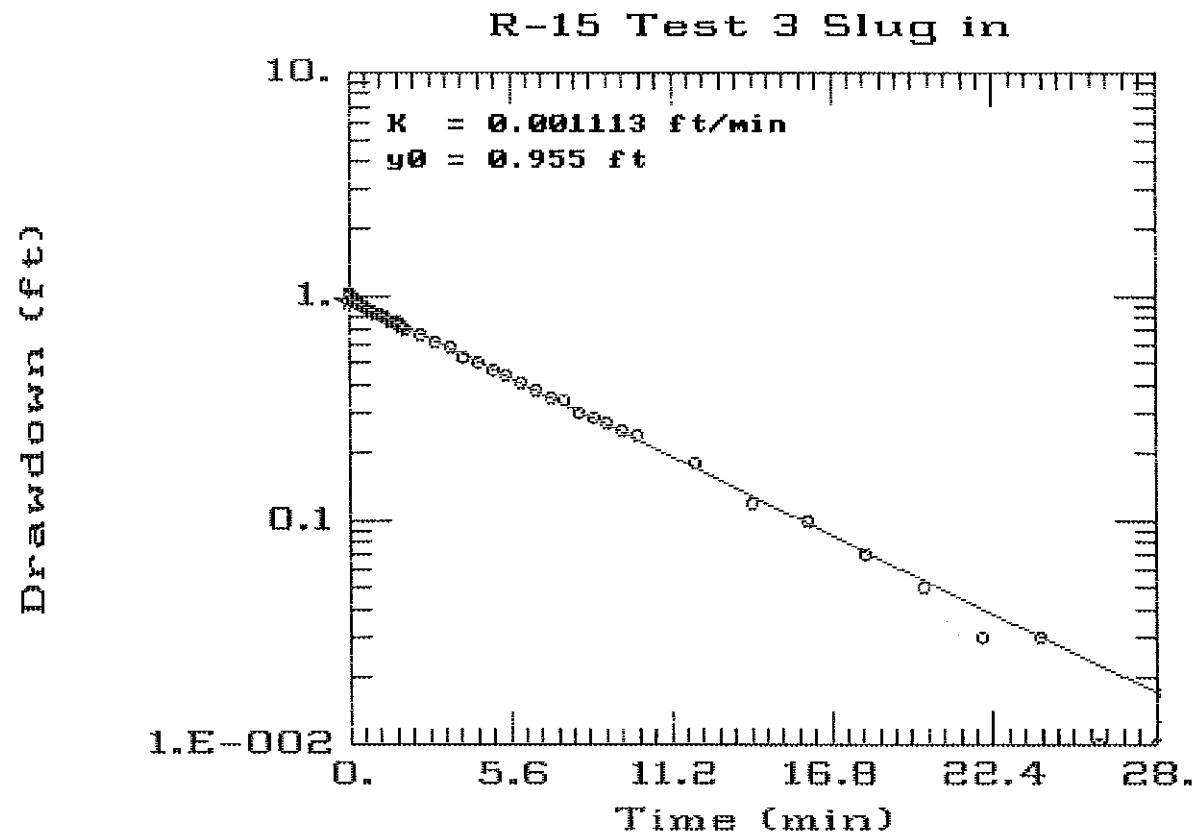
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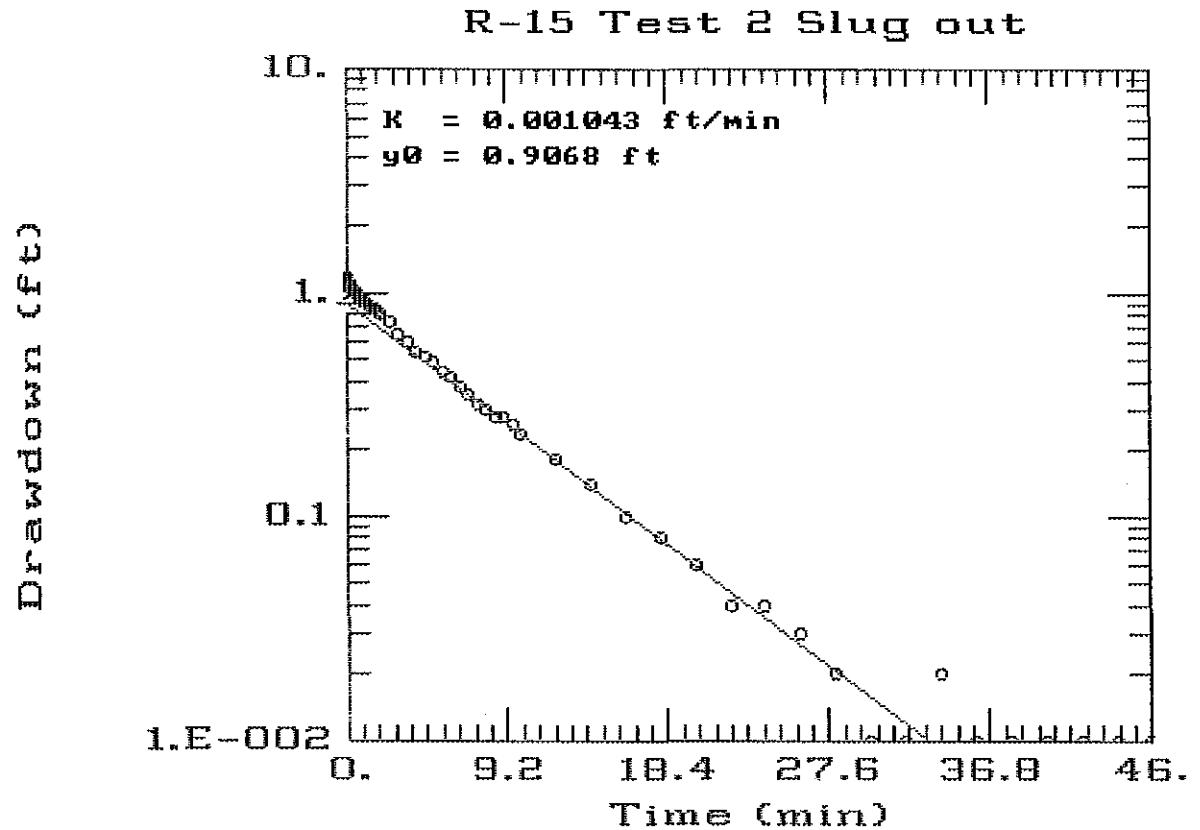
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Modeling Group

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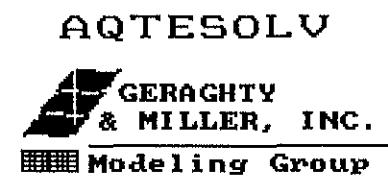
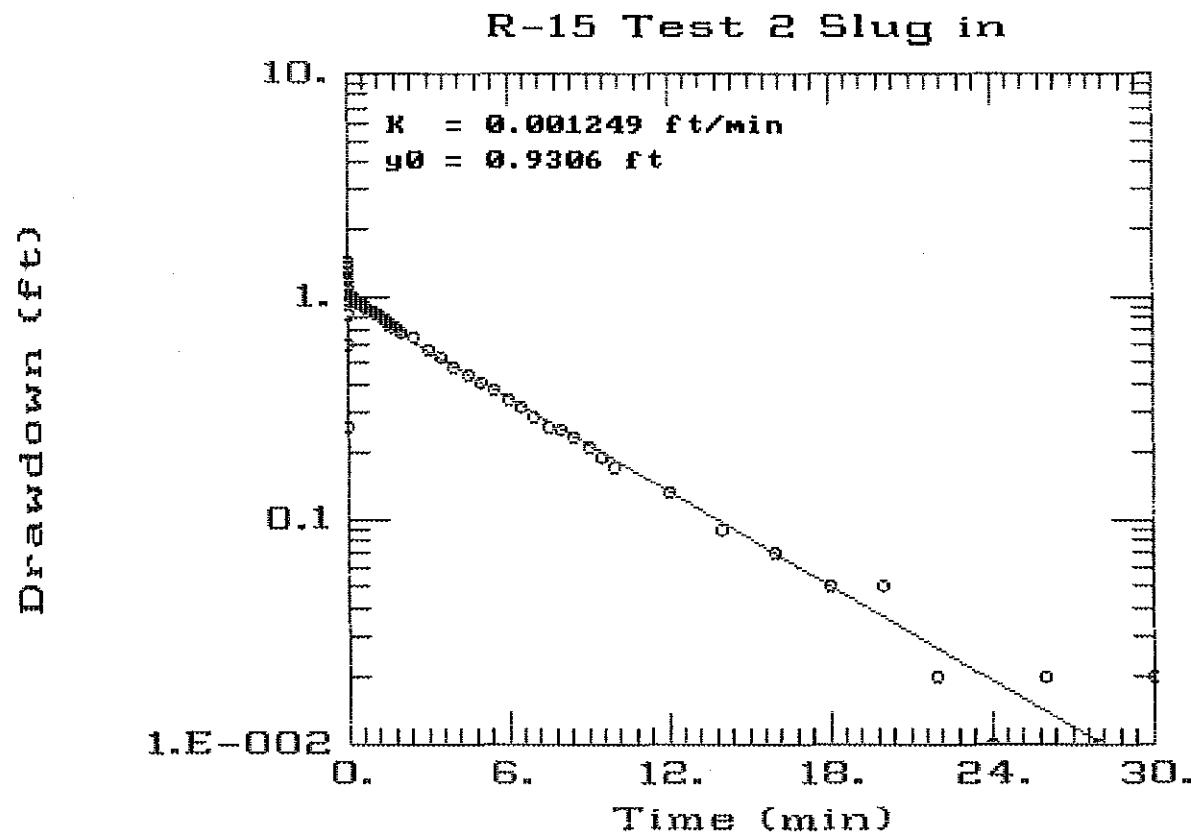
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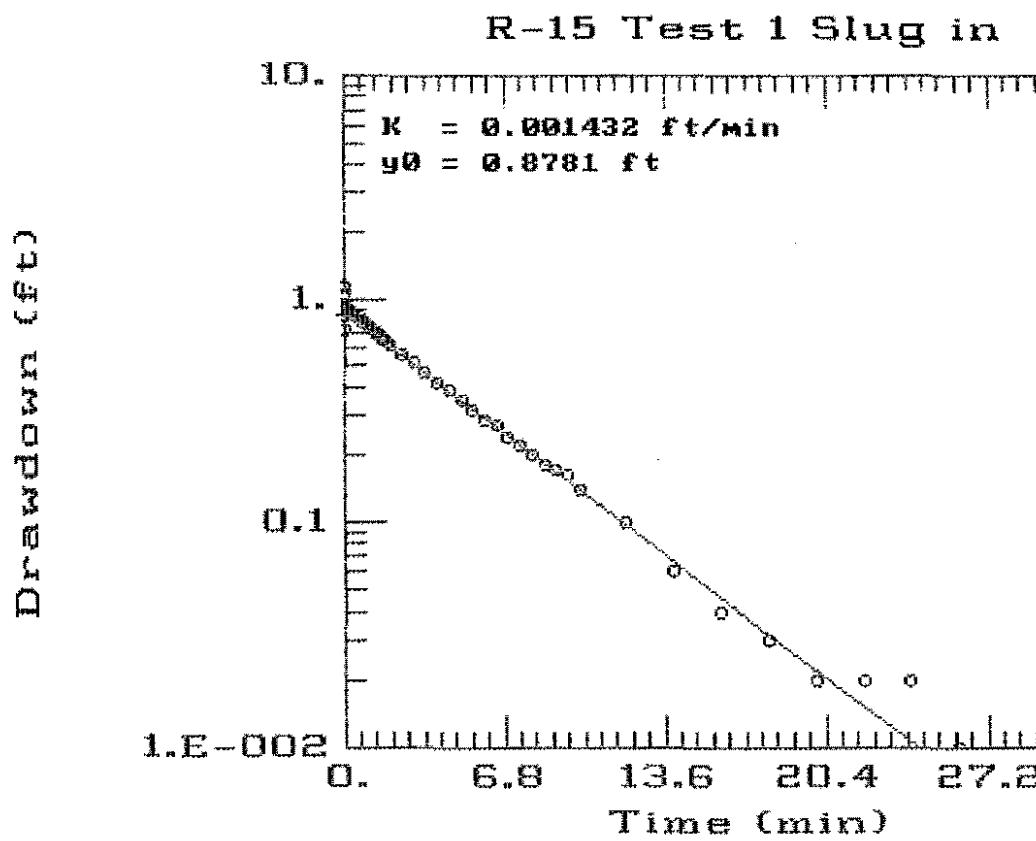


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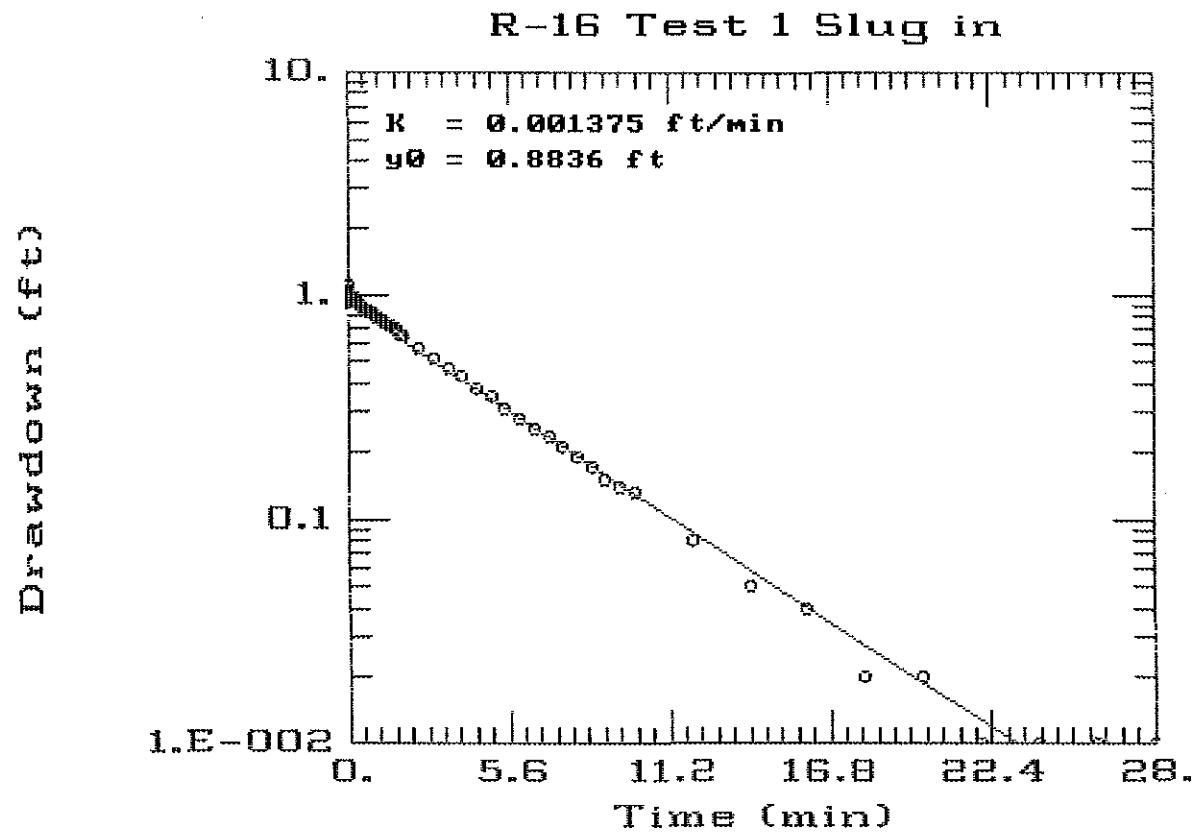


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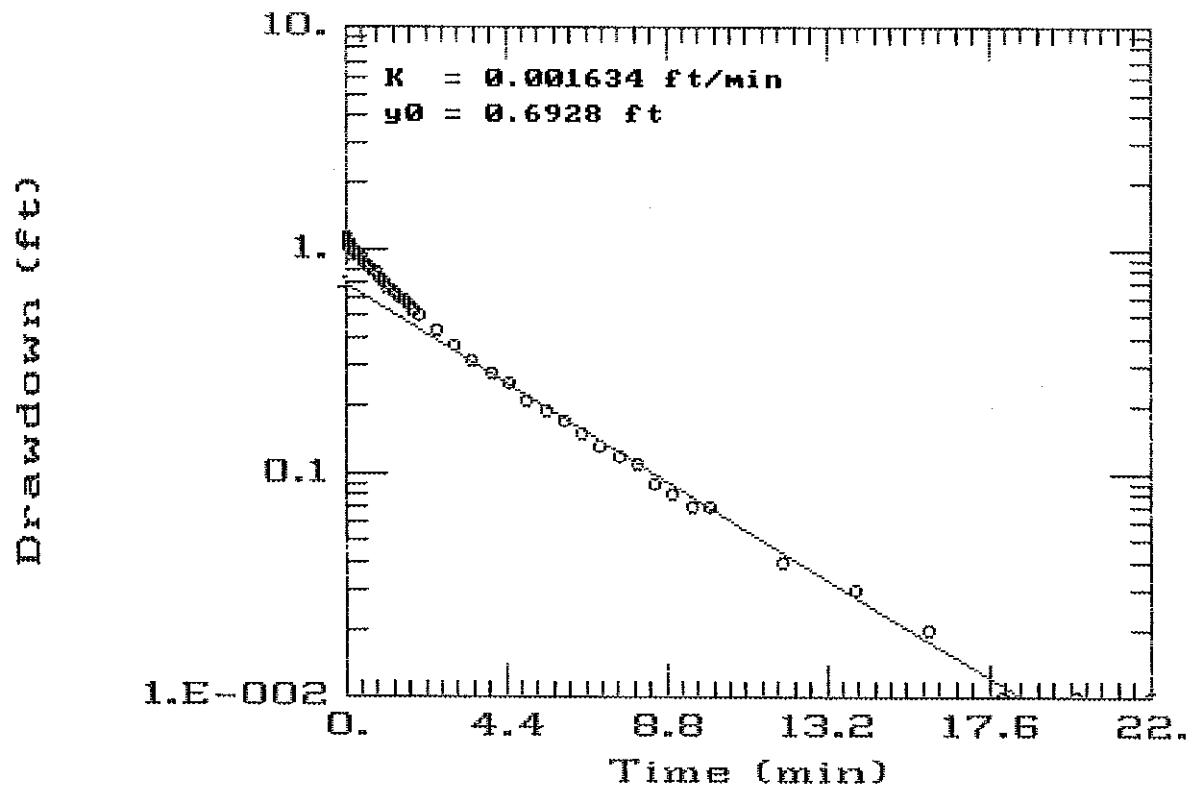
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& MILLER, INC.
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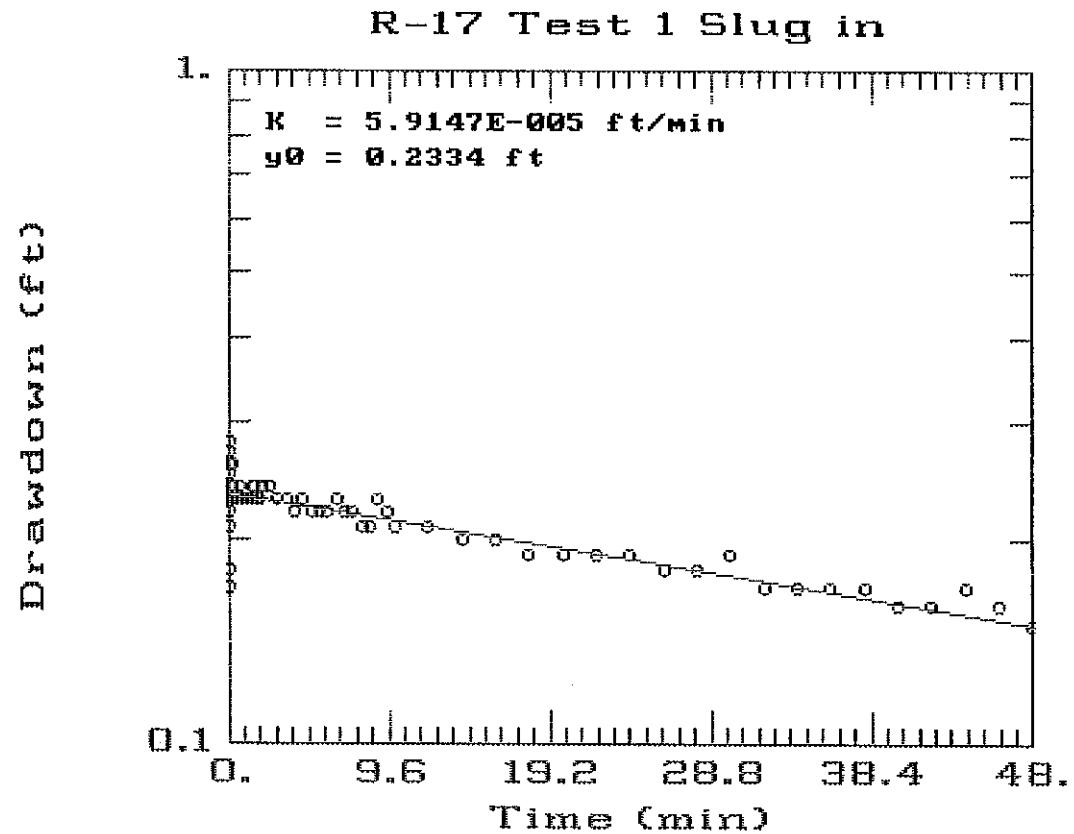
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R-16 Test 1 Slug out



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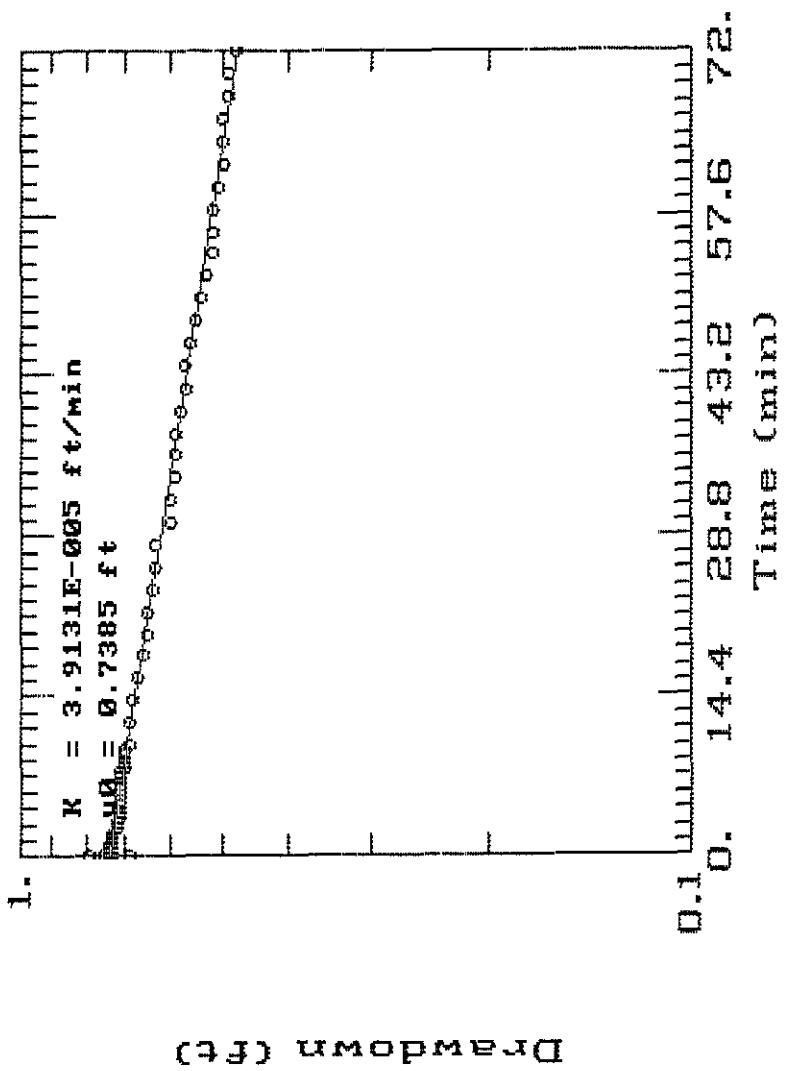


AQTESOLV
GERAGHTY & MILLER, INC.
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00055

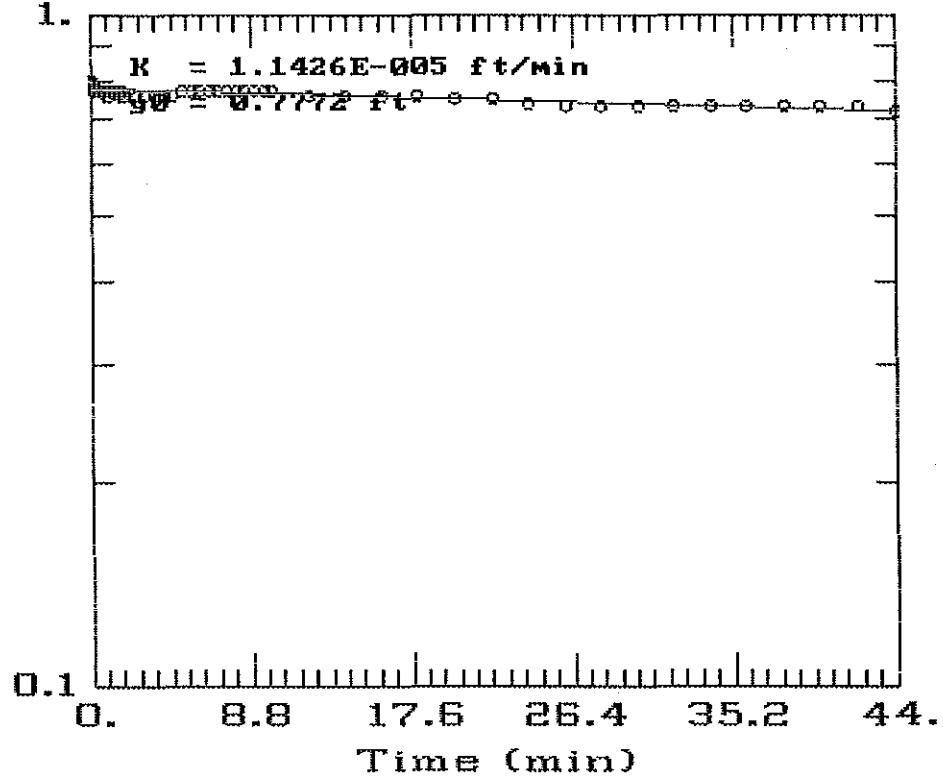
R-17 Test 2 Slug in



R-17 Test 2 Slug out

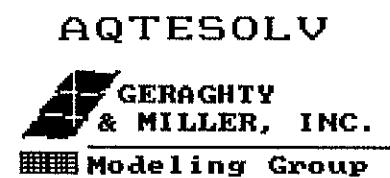
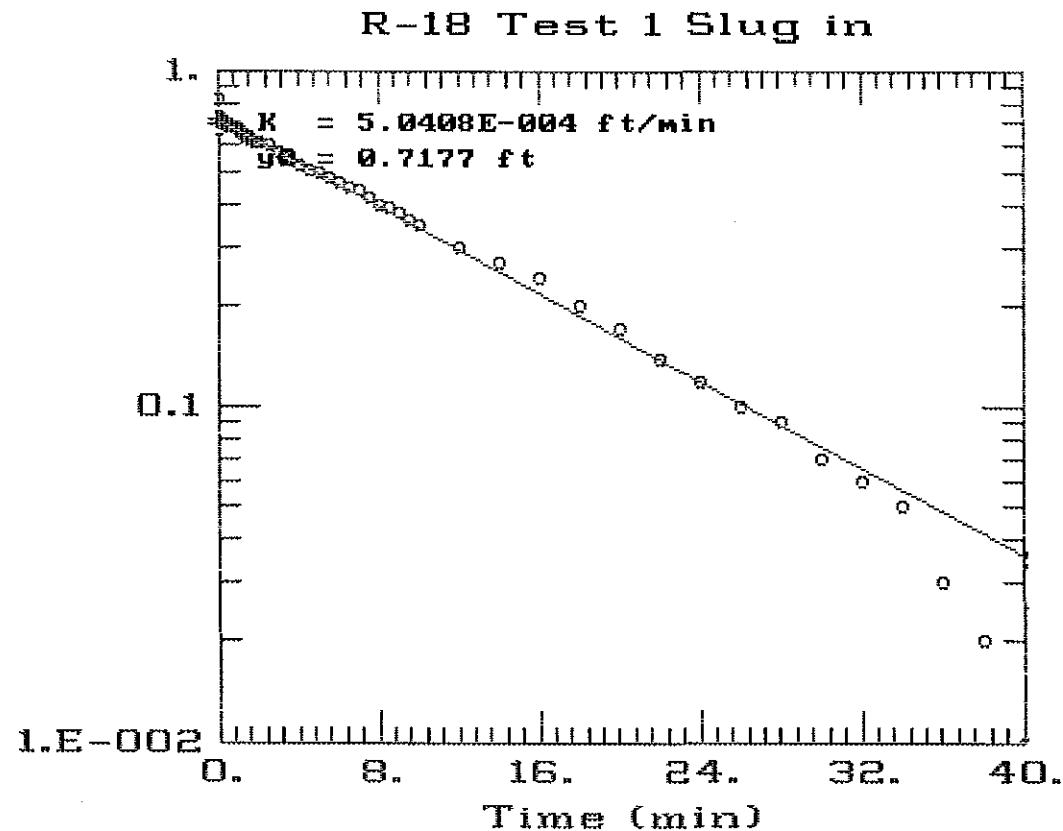
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Drawdown (ft)



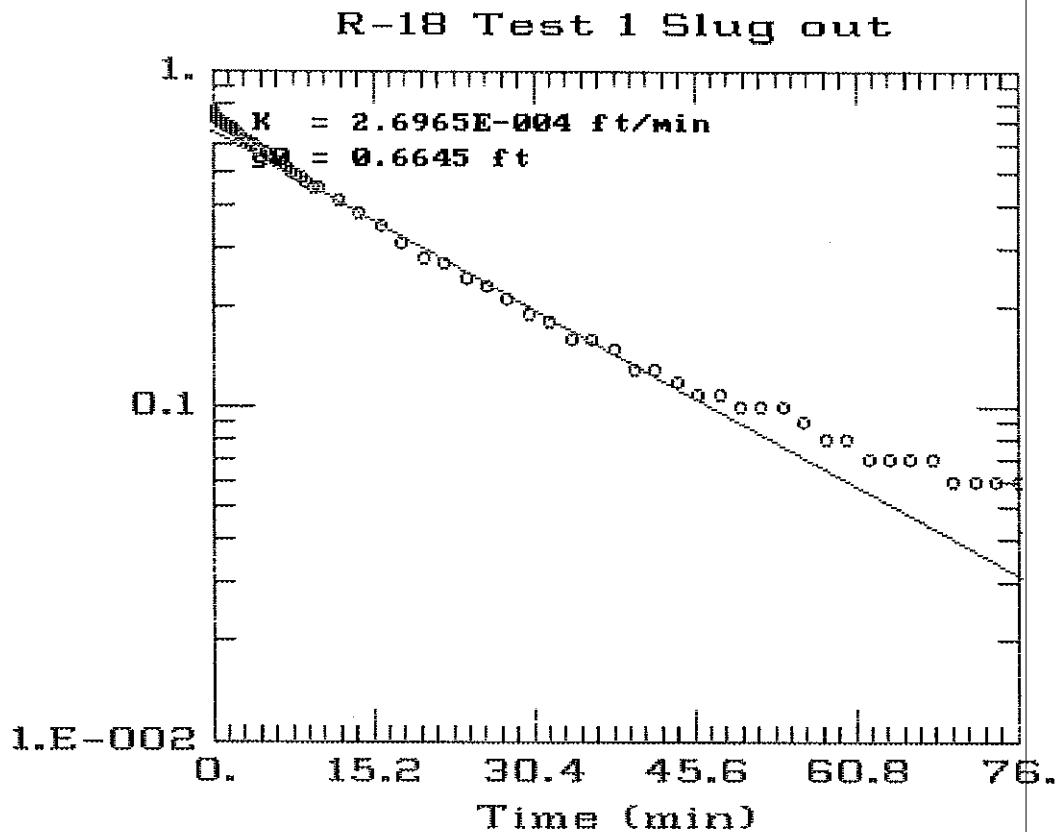
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Drawdown (ft)



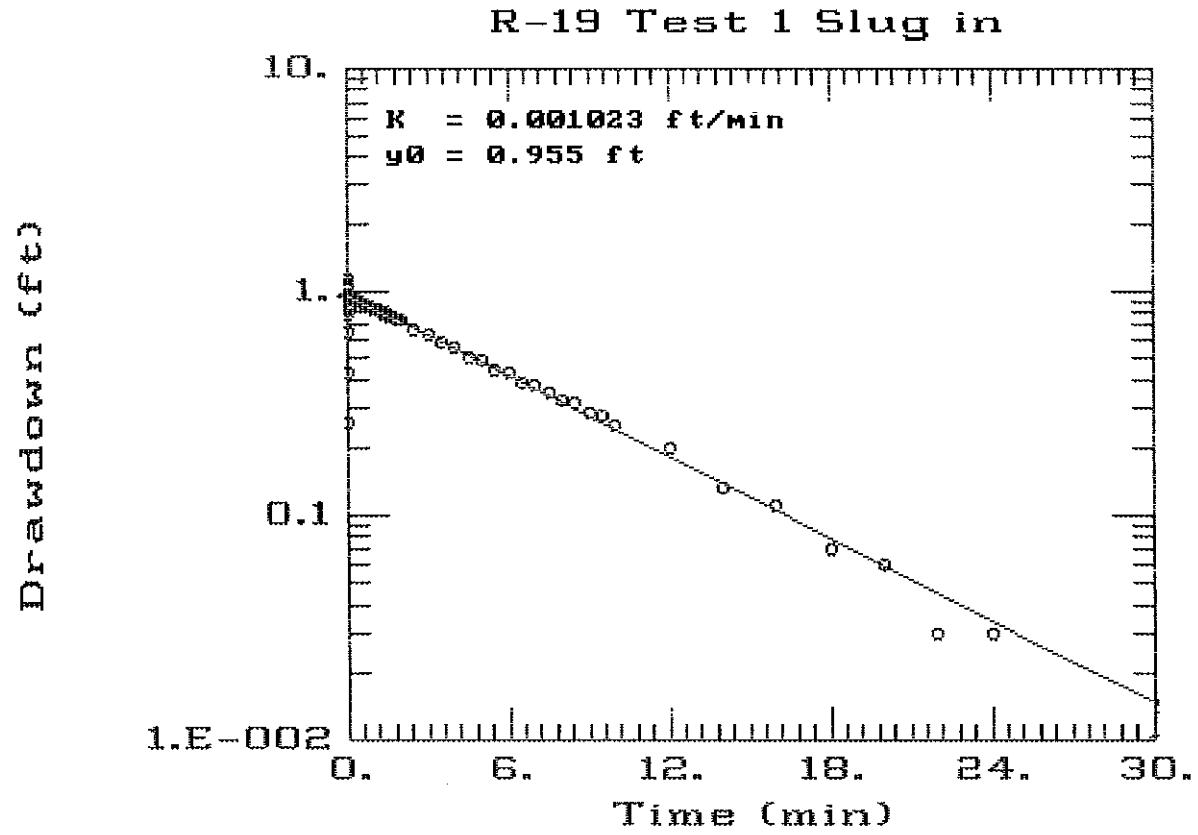
45000

Drawdown (ft)



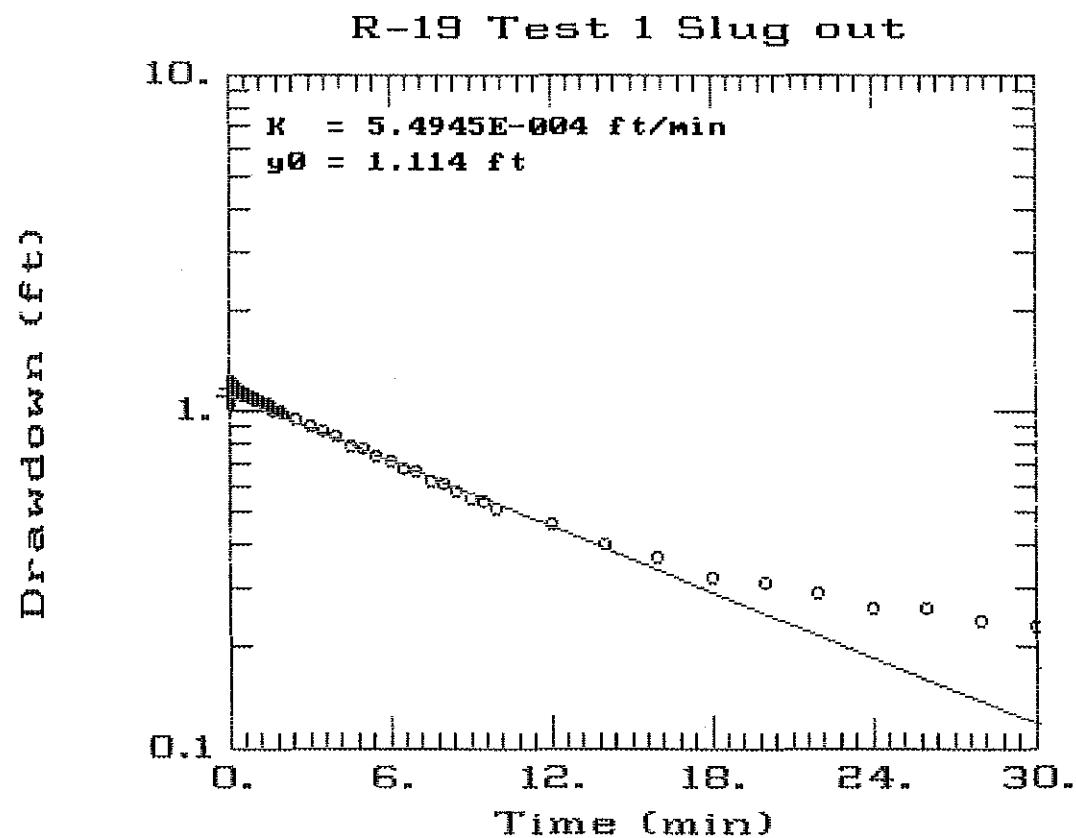
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00058



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GERAGHTY & MILLER, INC.
Modeling Group

62000

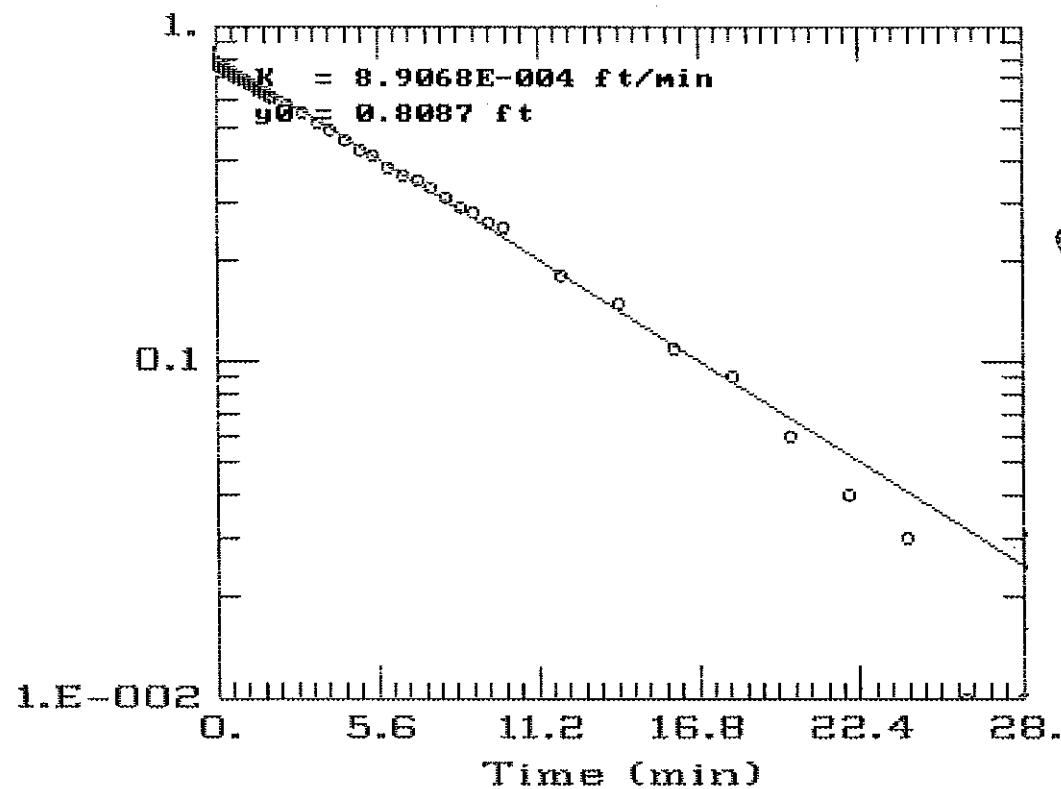


AQTESOLV
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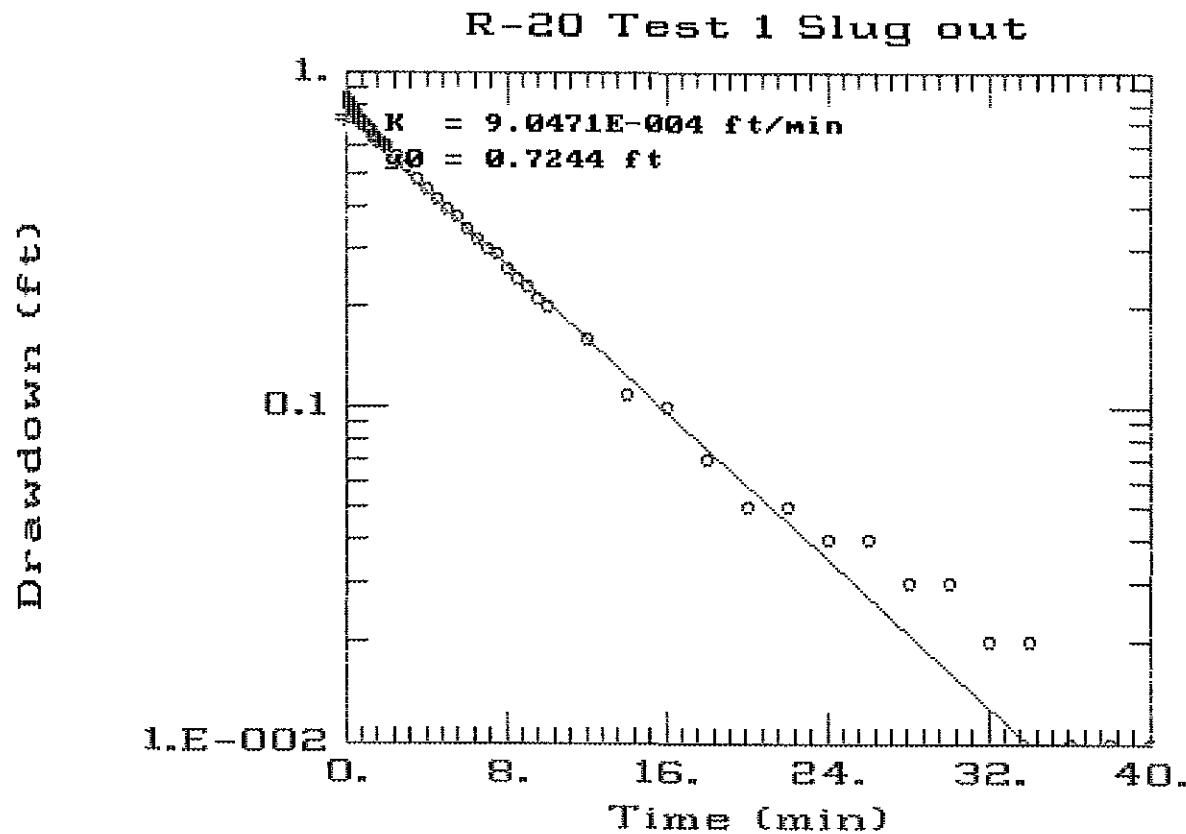
Drawdown (ft)

R-20 Test 1 Slug in



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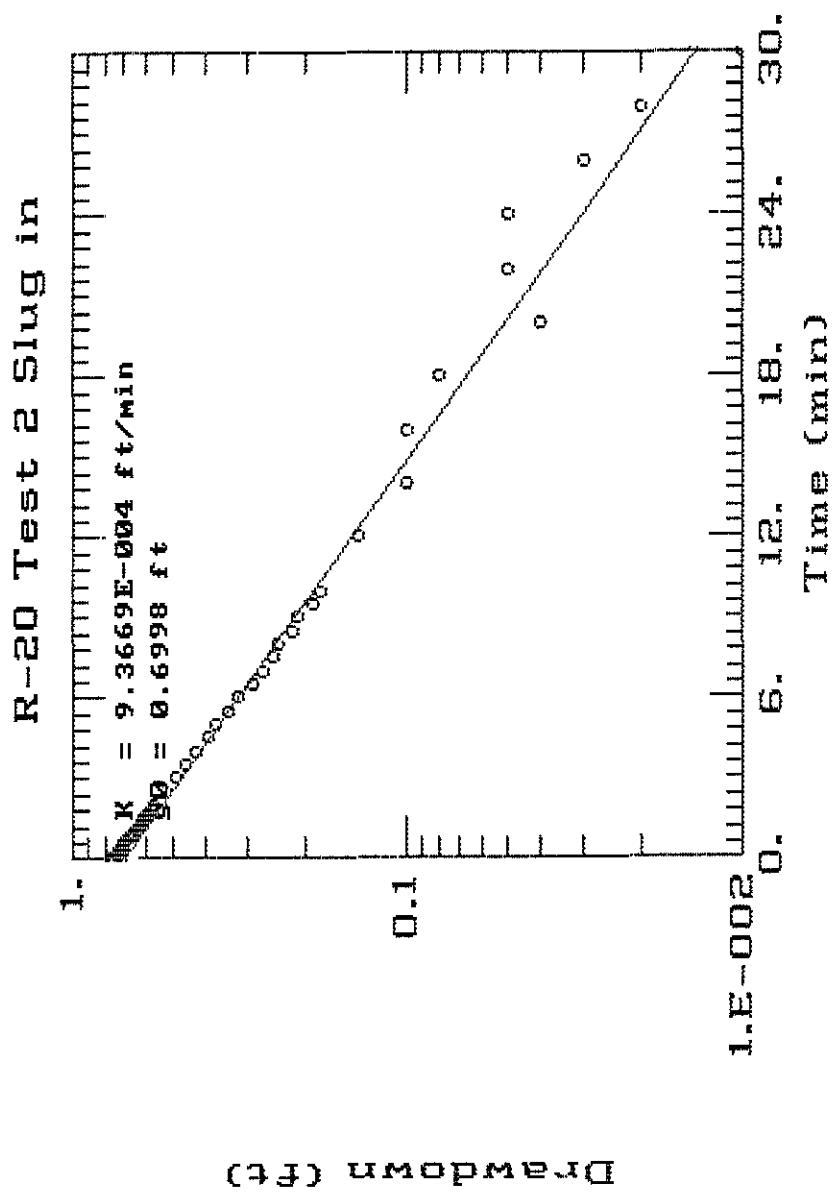
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& MILLER, INC.
Modeling Group

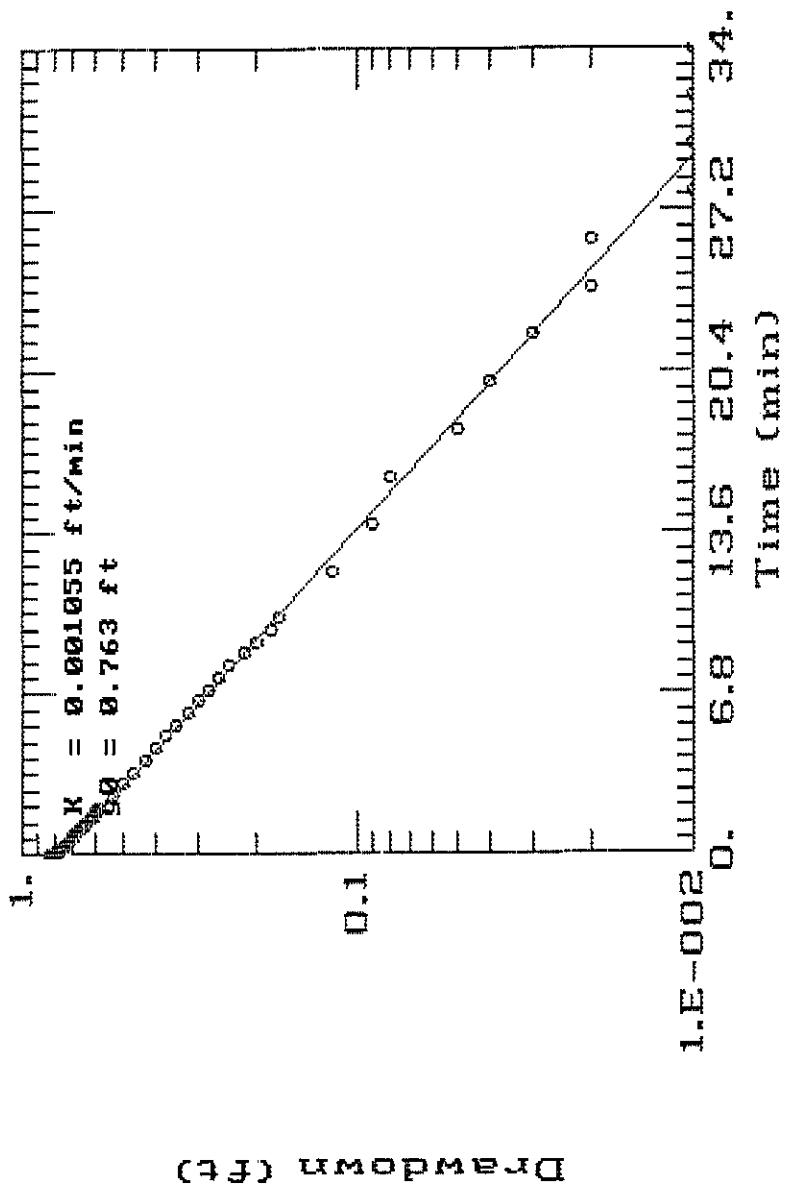
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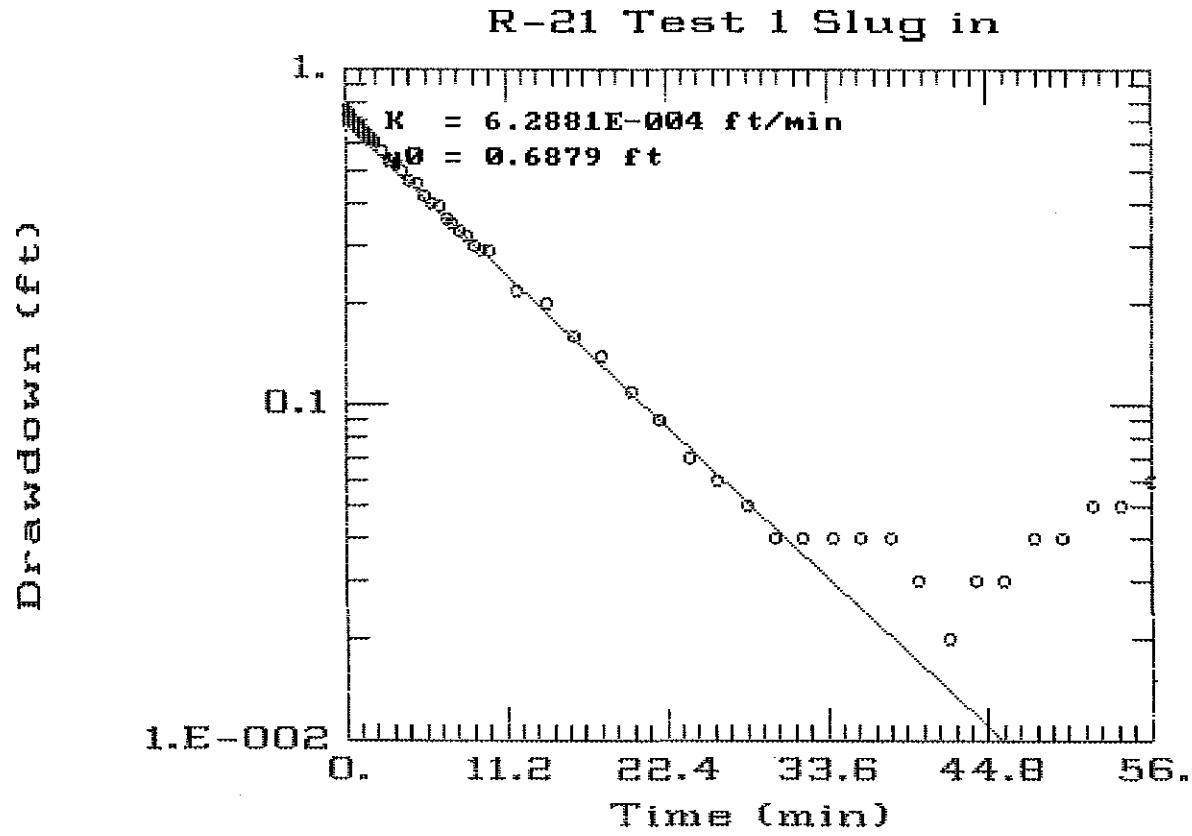
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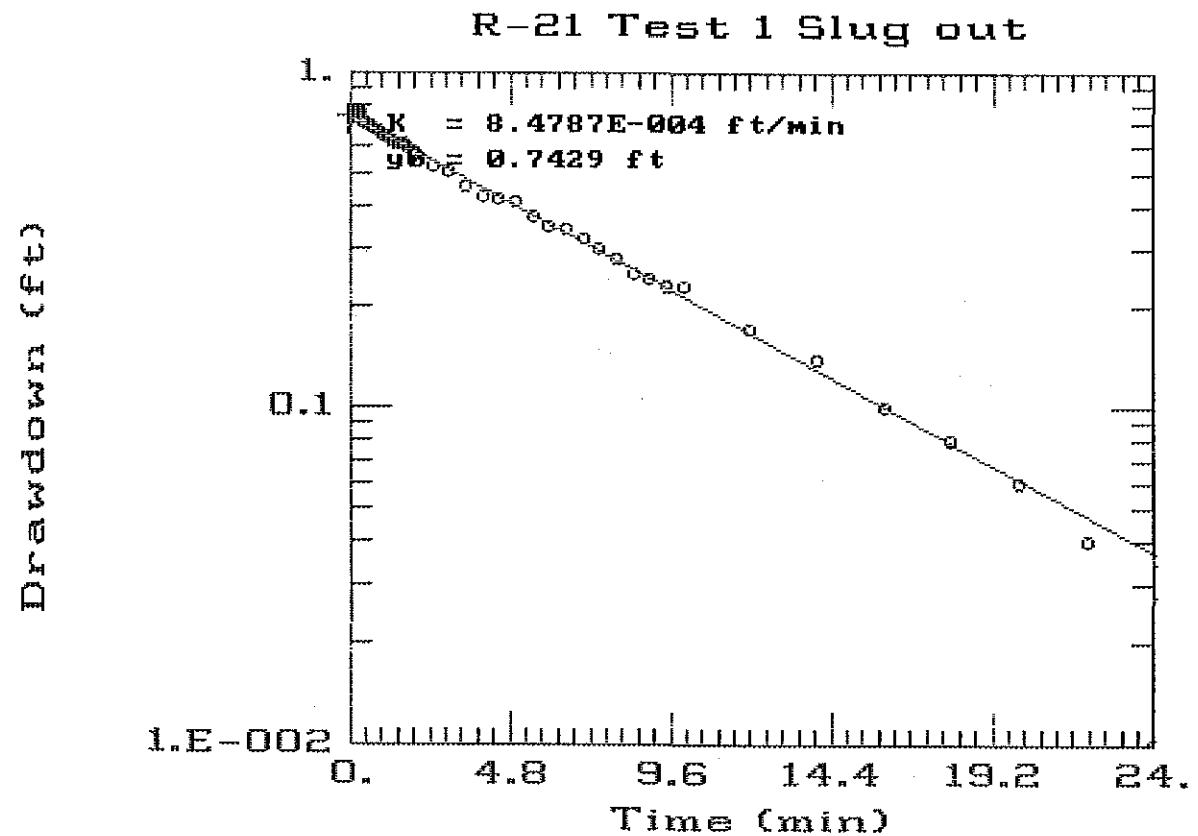
R-20 Test 2 Slug out





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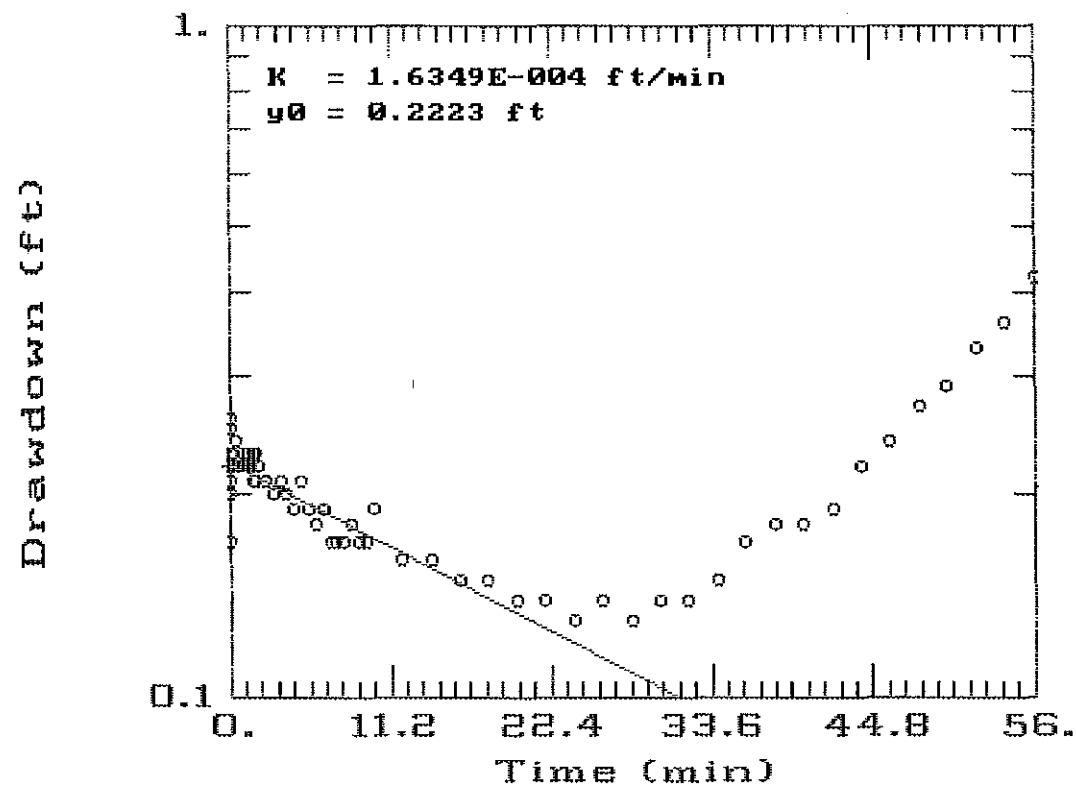
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& MILLER, INC.
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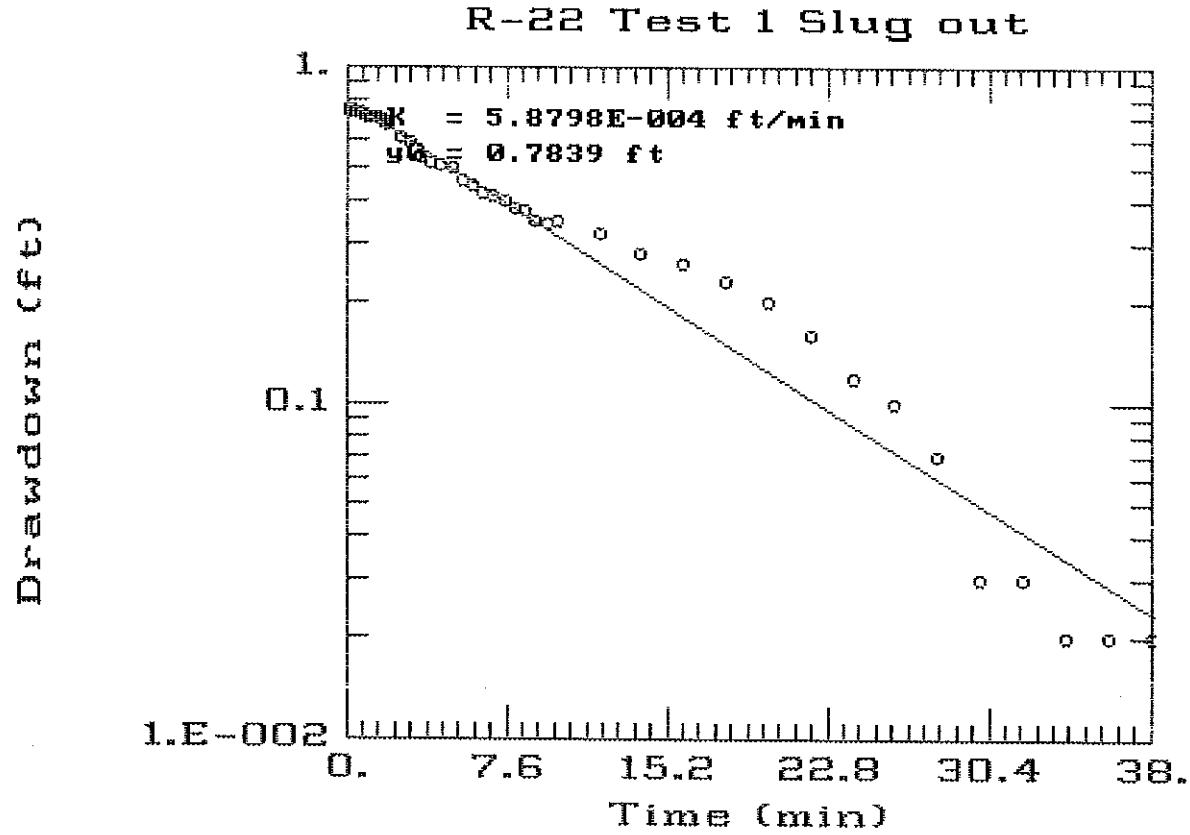
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R-22 Test 1 Slug in



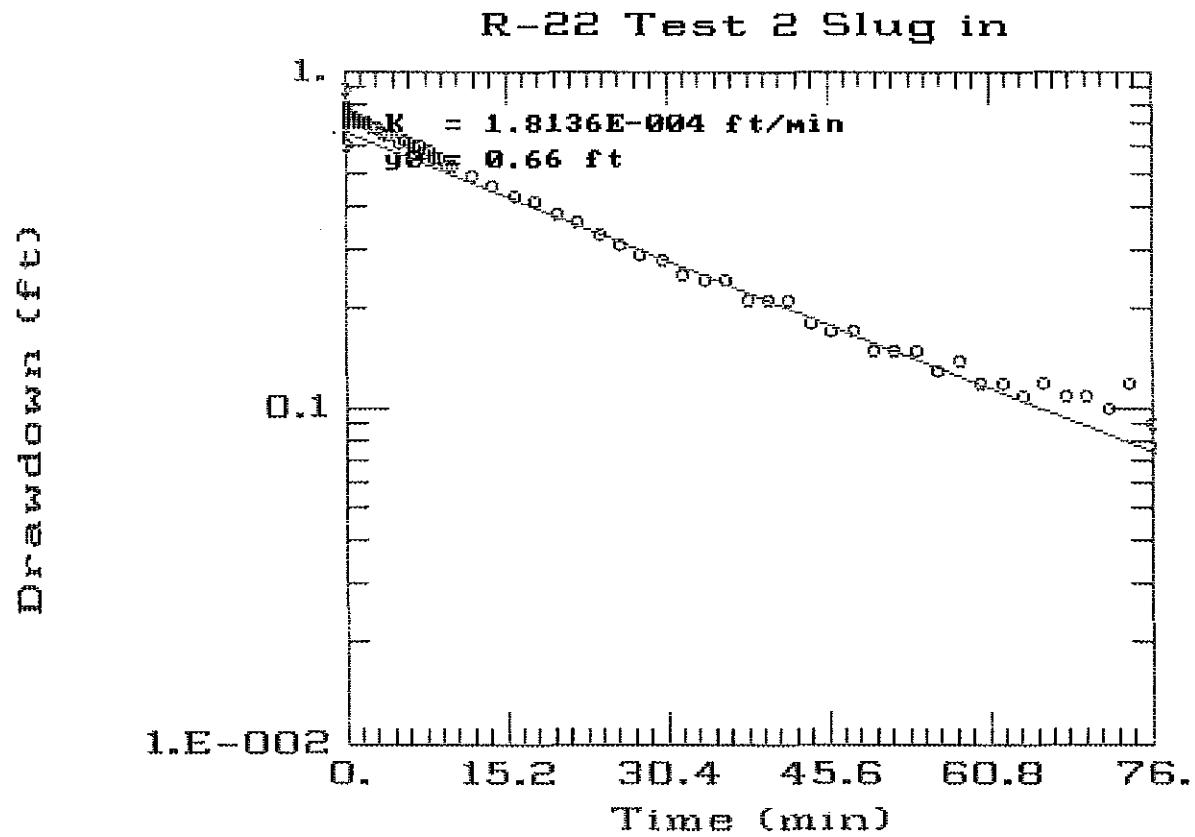
AQTESOLV
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& MILLER, INC.
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49000



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GERAGHTY & MILLER, INC.
Modeling Group

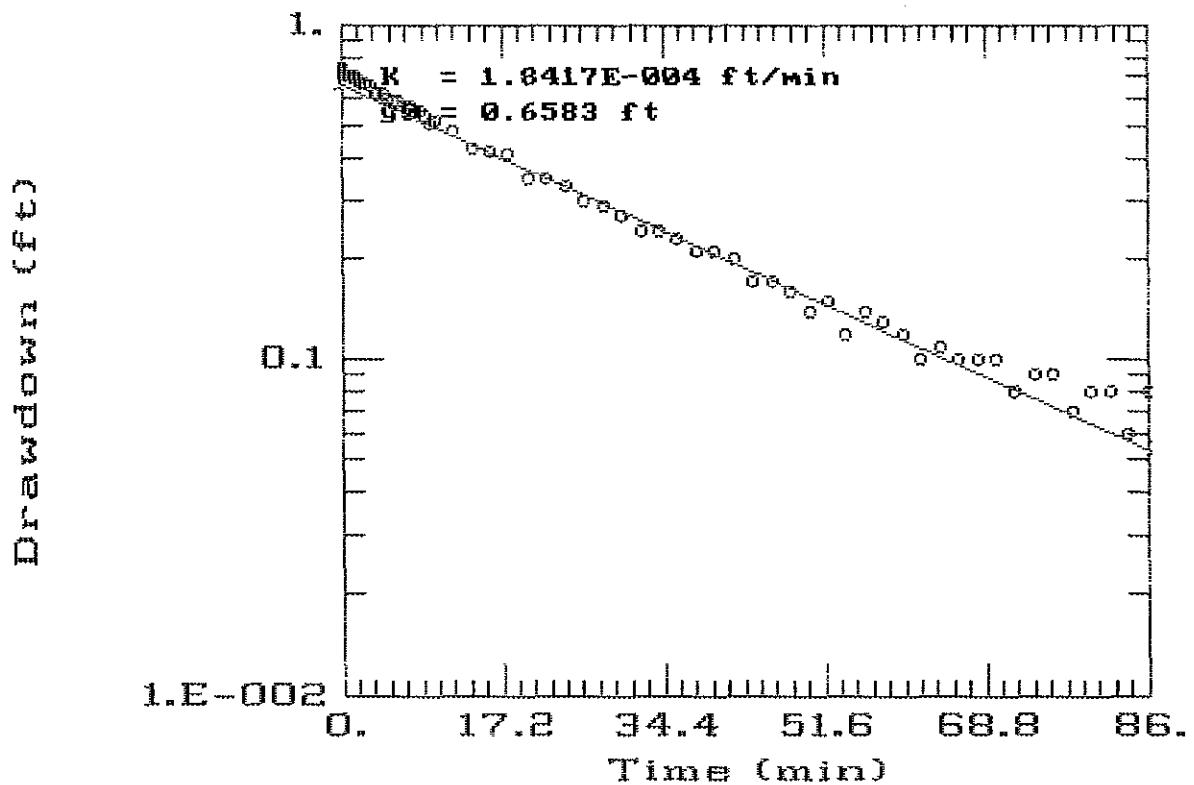
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AQTESOLV
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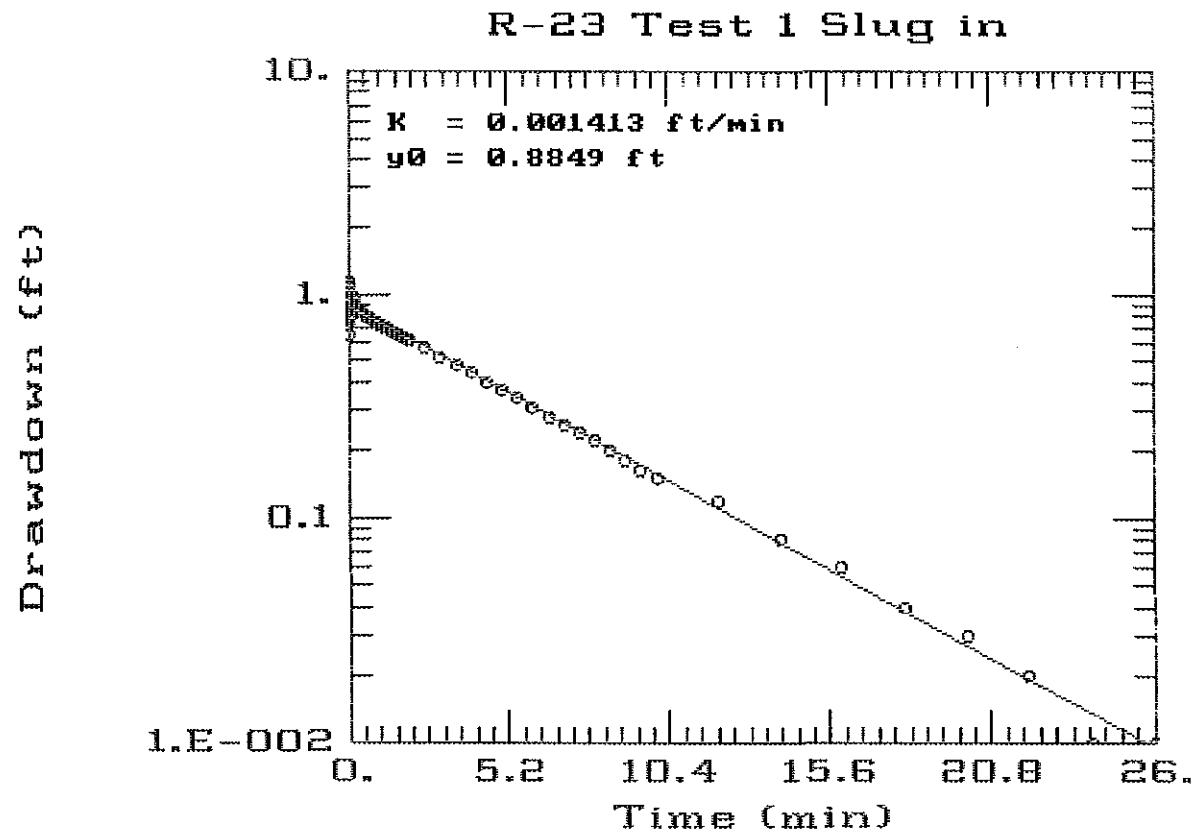
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R-22 Test 2 Slug out



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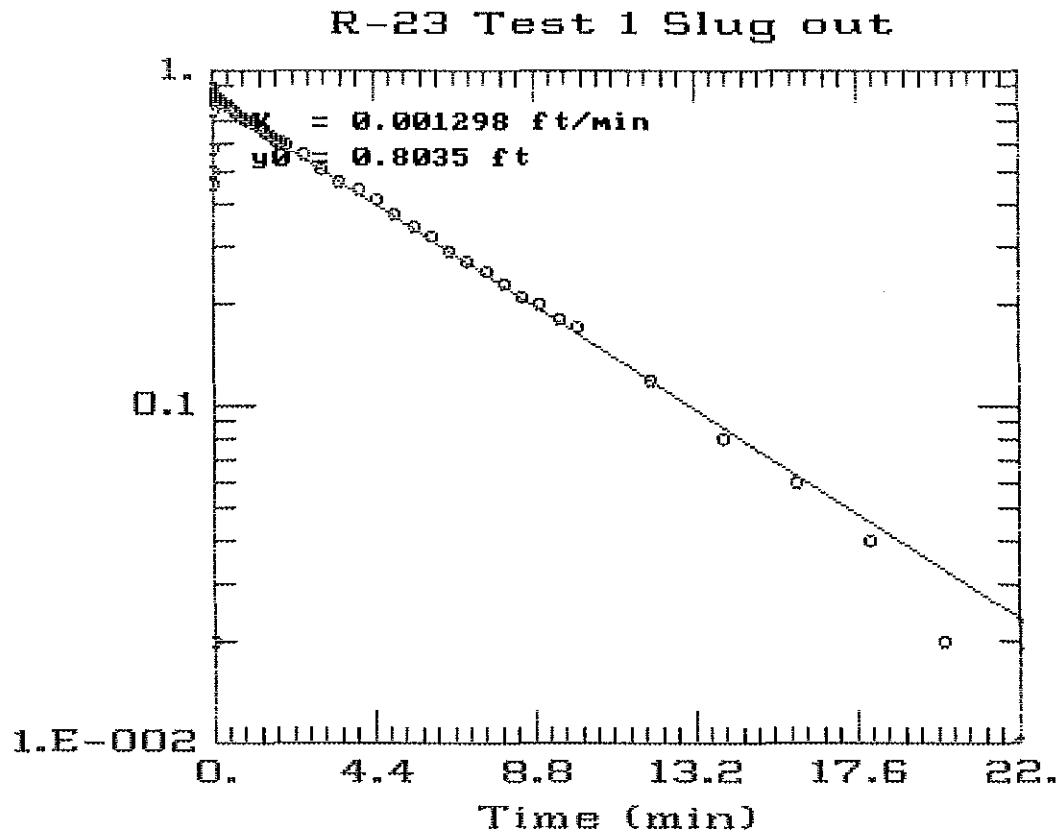
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T6000

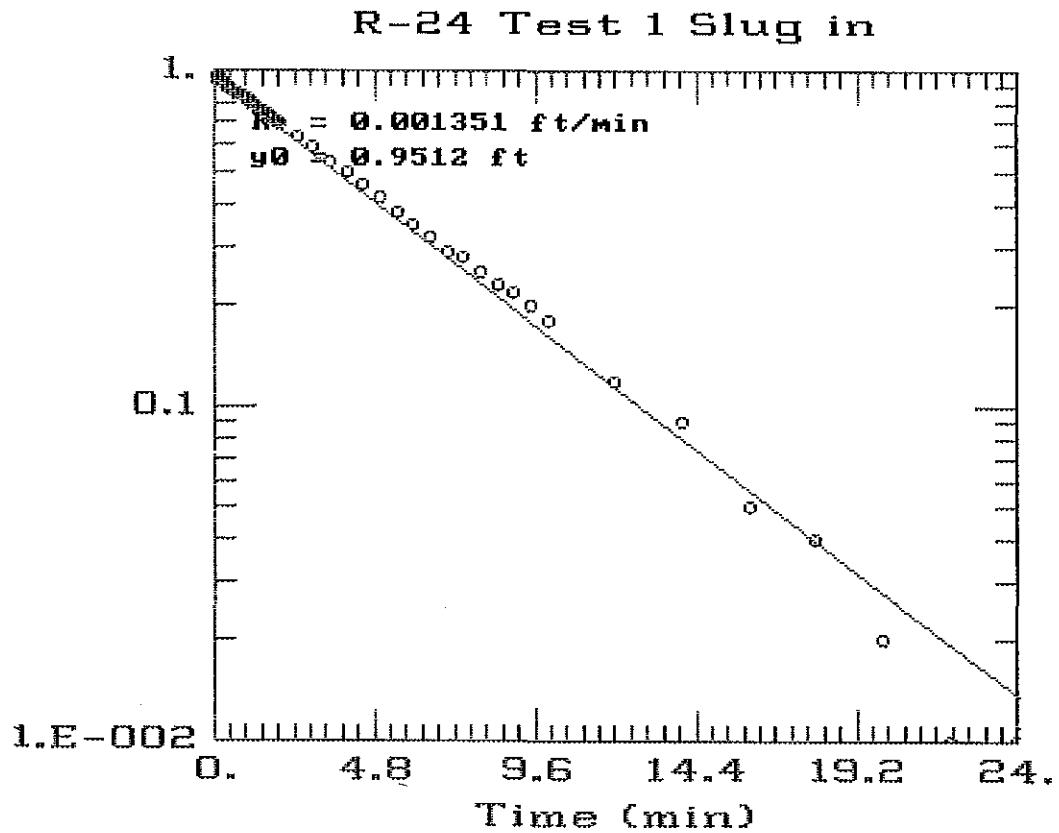
Drawdown (ft)



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& MILLER, INC.
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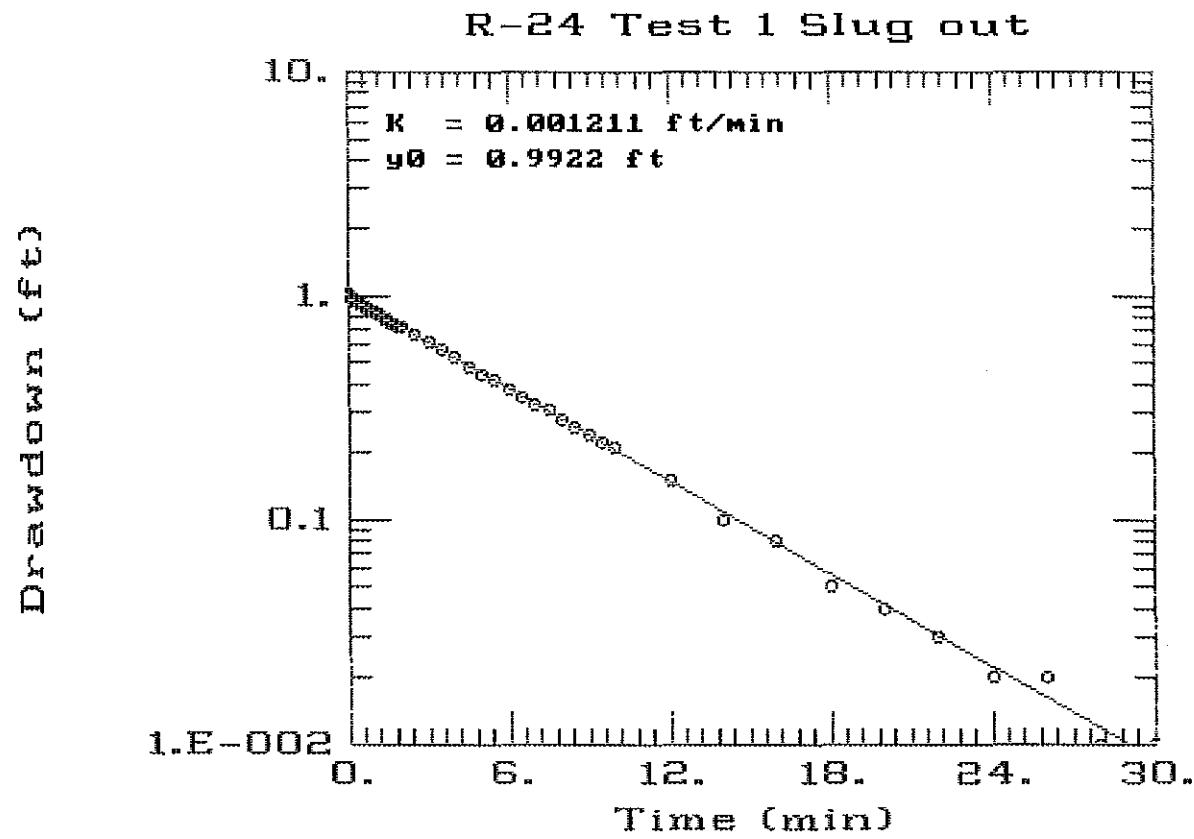
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Drawdown (ft)



AQTESOLV
 GERAGHTY
& MILLER, INC.
Modeling Group

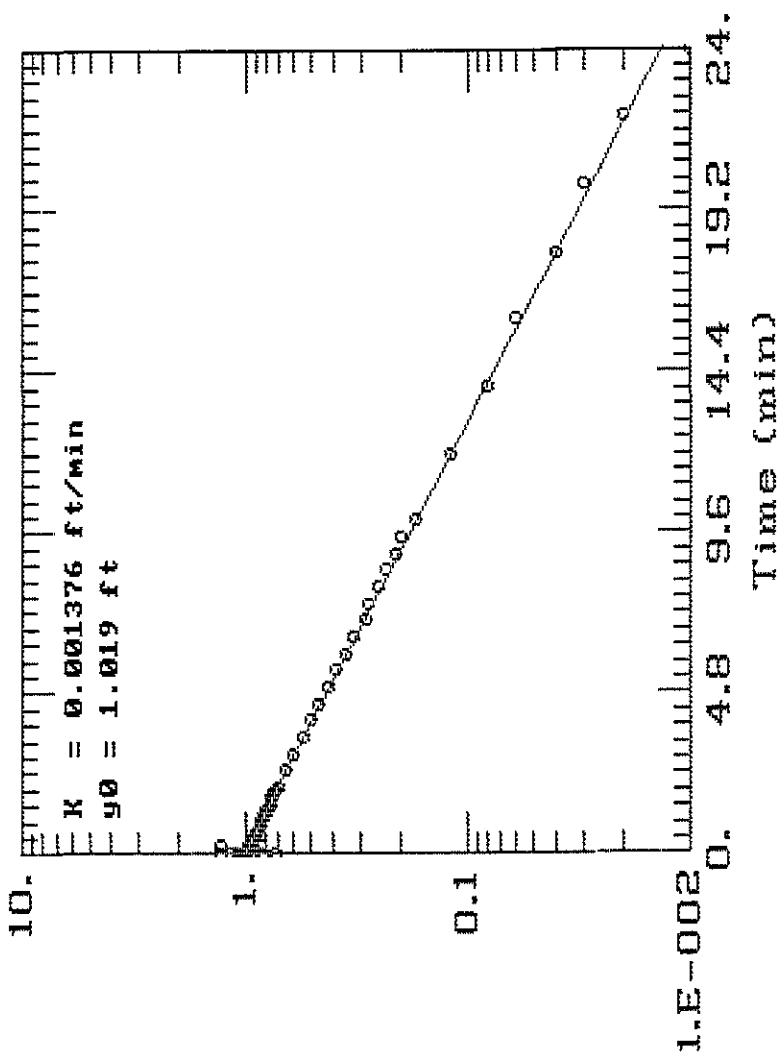
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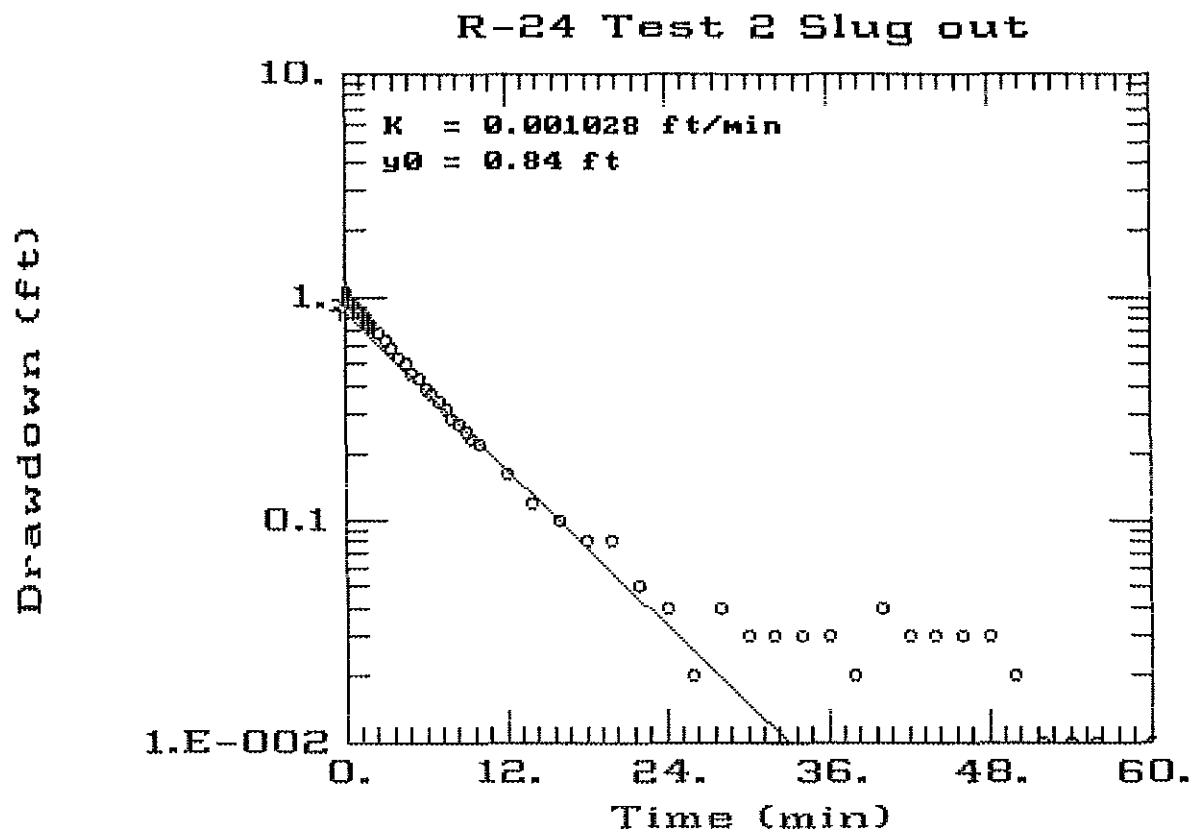
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GERAGHTY & MILLER, INC.
Modeling Group

00075

R-24 Test 2 Slug in

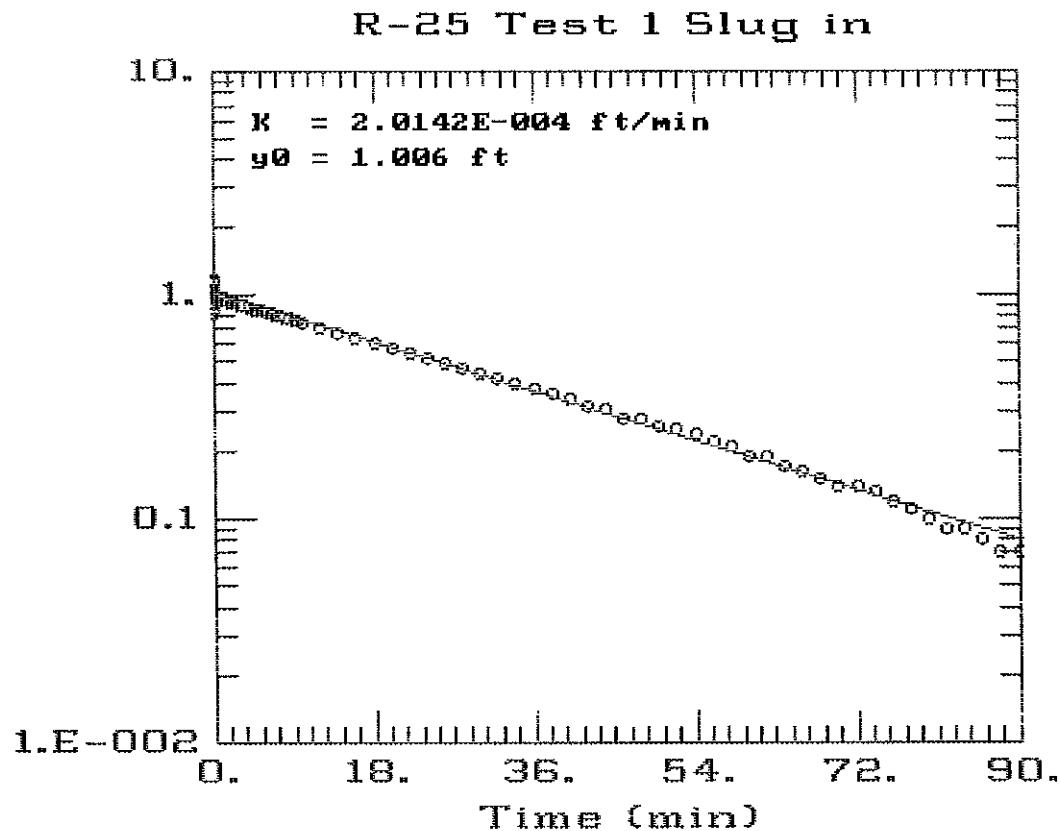


Drawdown (ft)



9/00/96

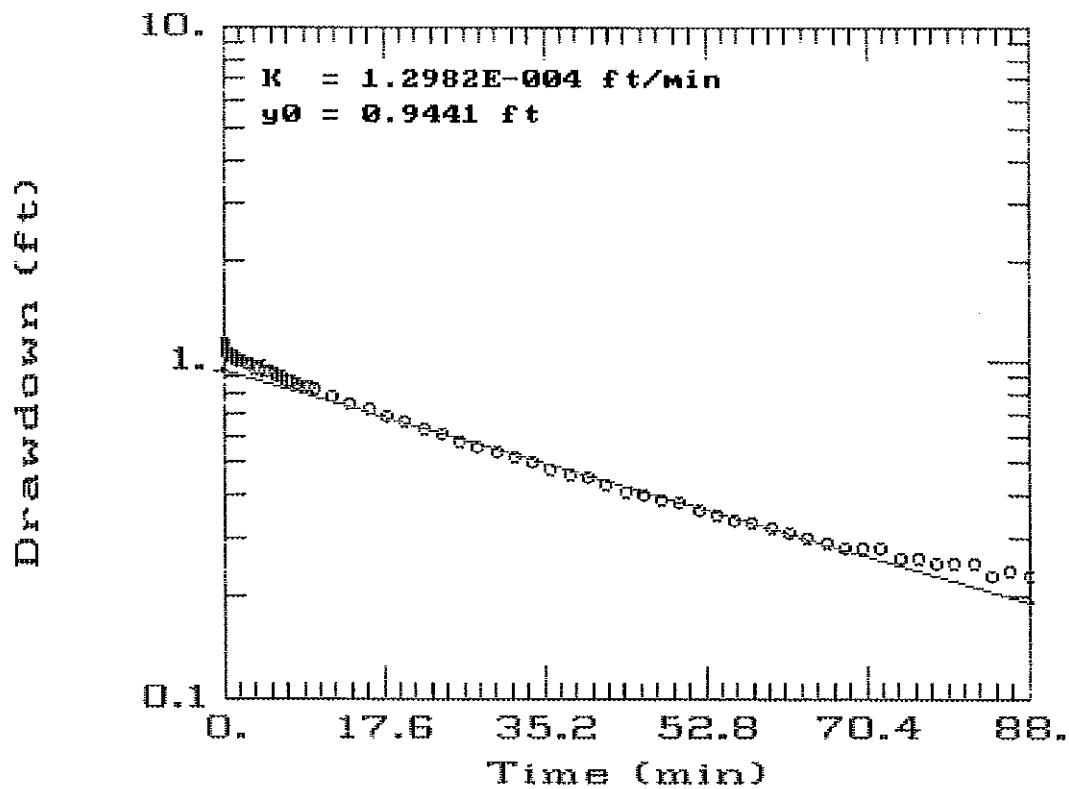
Drawdown (ft)



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46000
47000

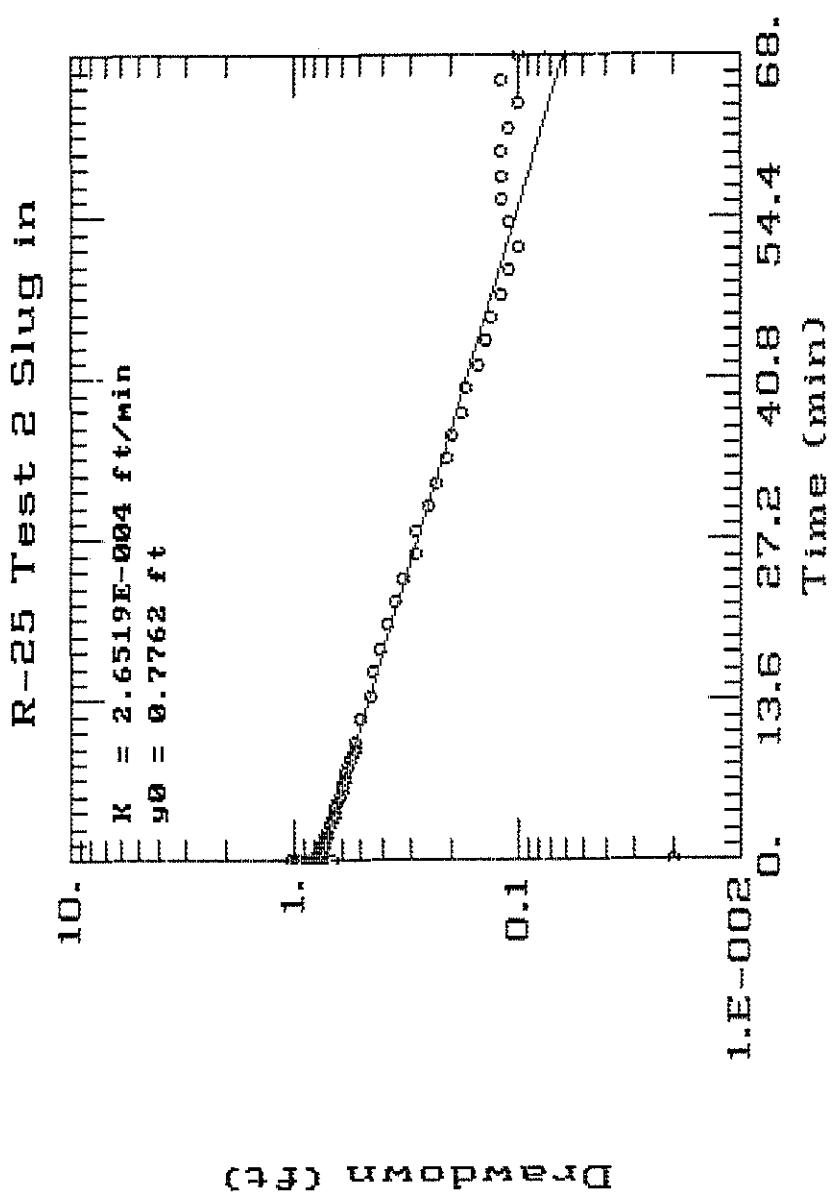
R-25 Test 1 Slug out



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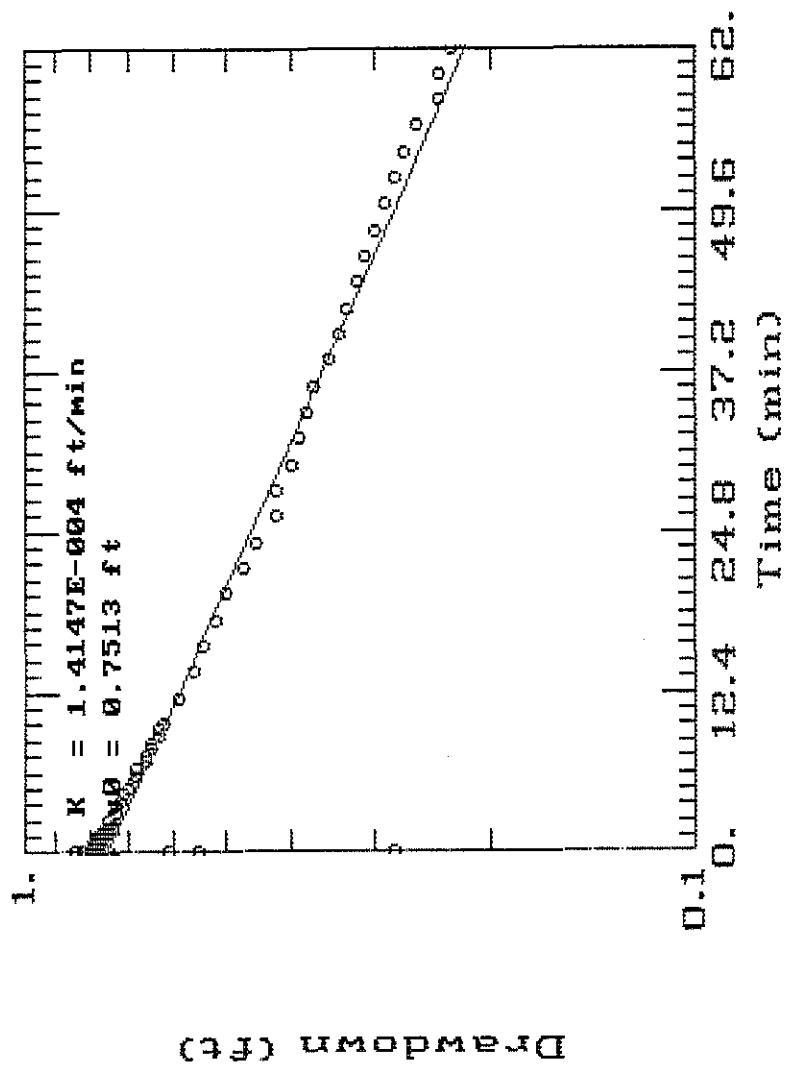
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00079



00080

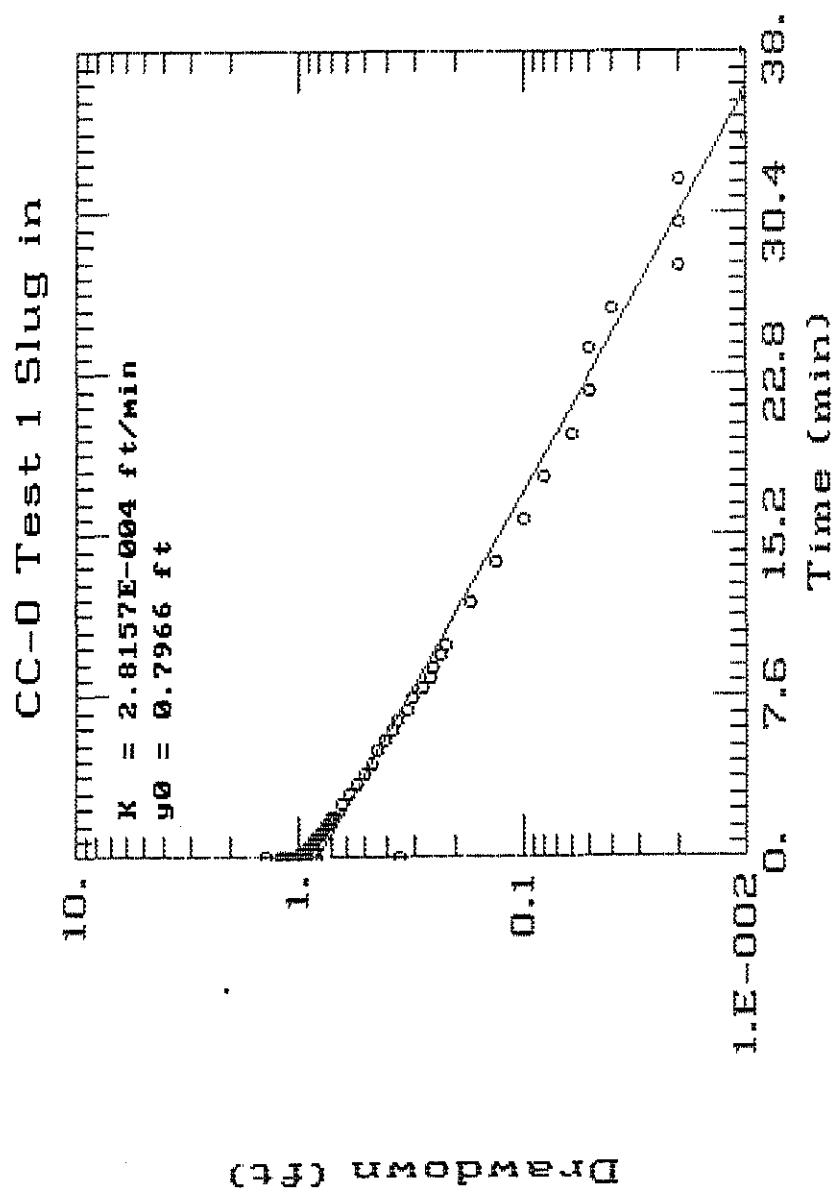
R-25 Test 2 Slug out



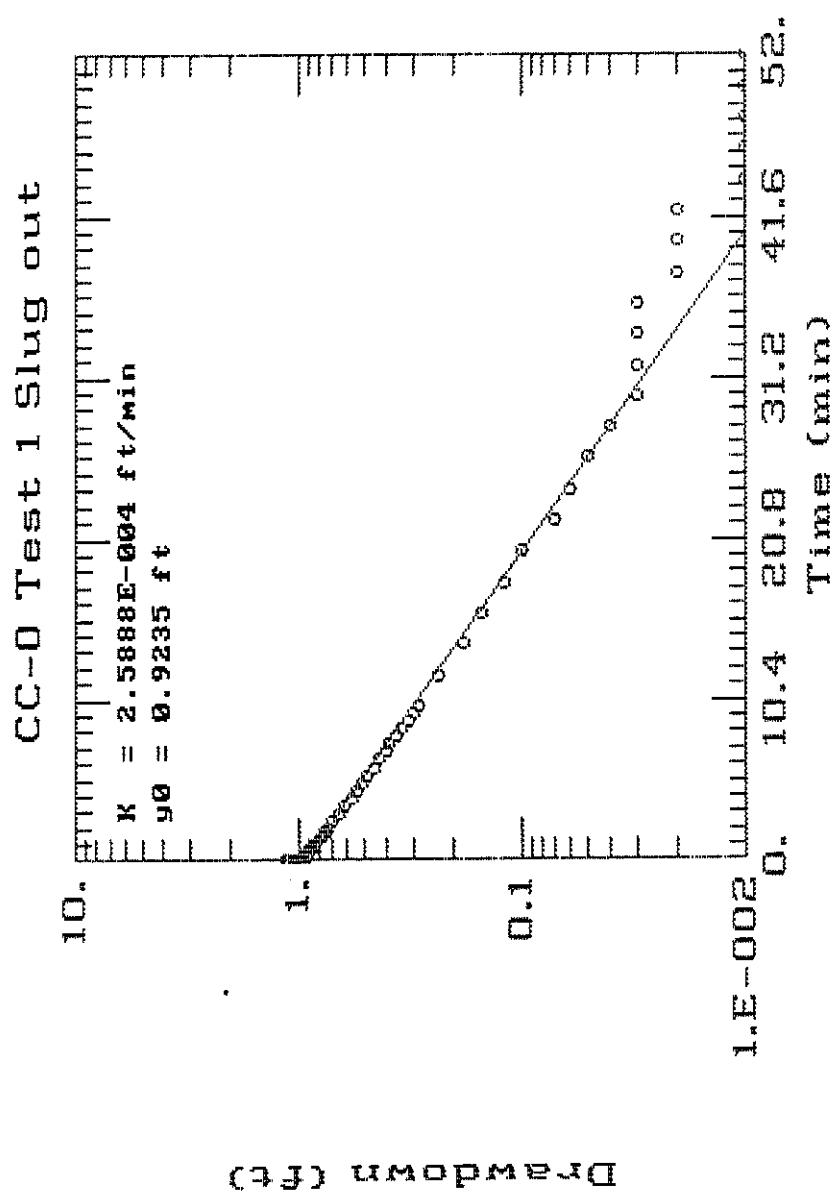
00081

Piezometer (slug in and slug out) tests - Site 2

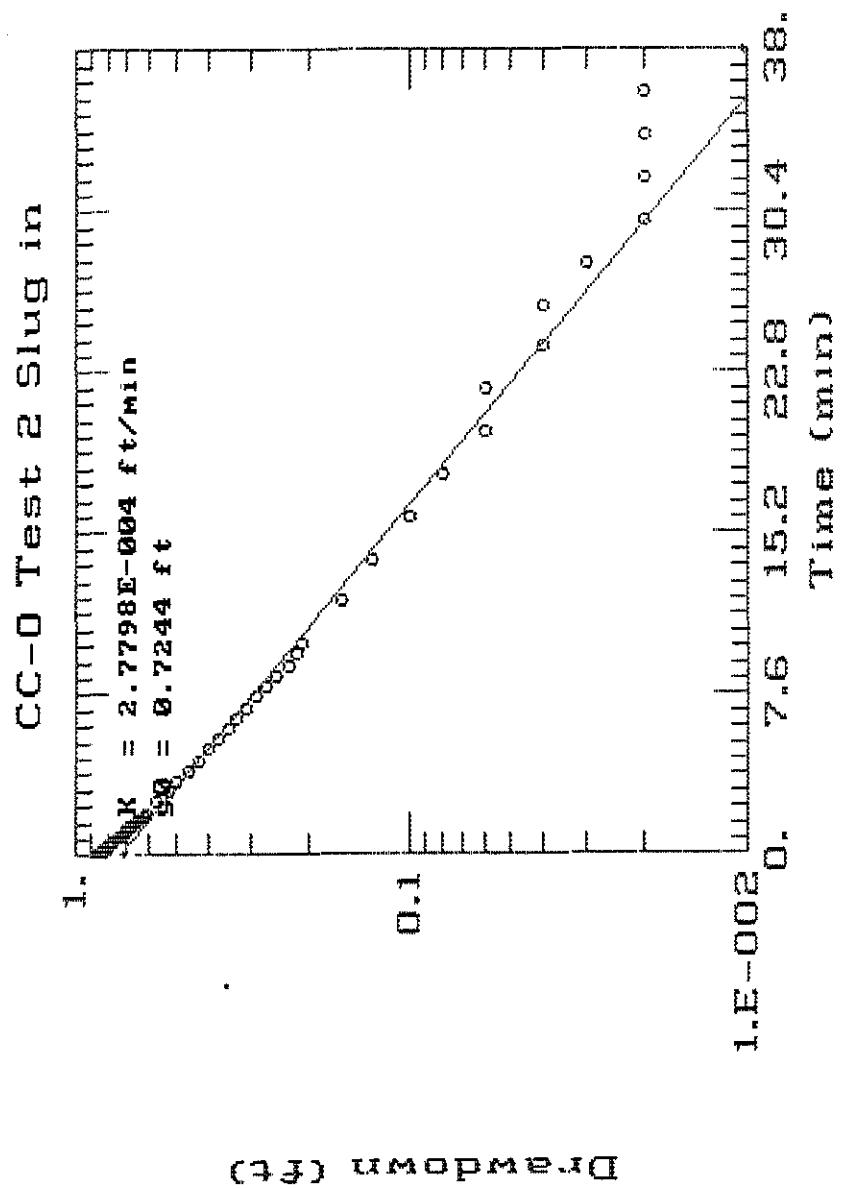
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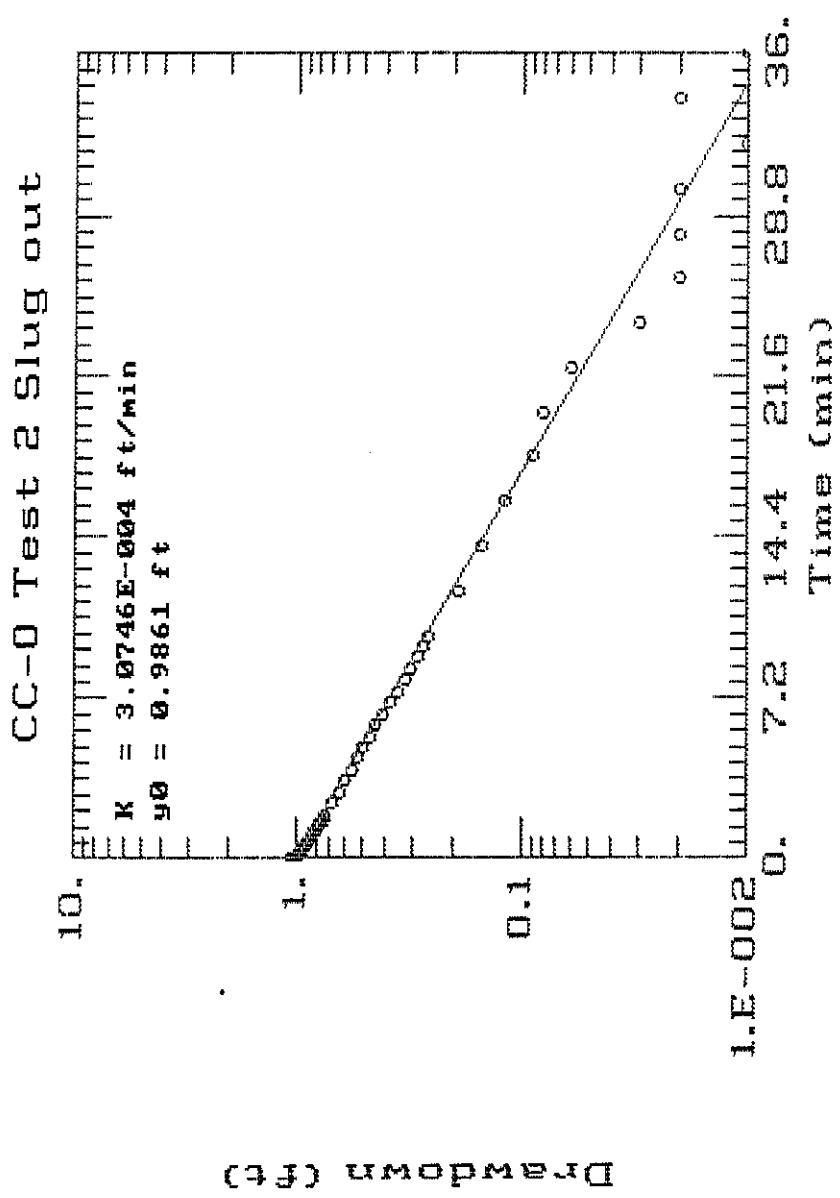
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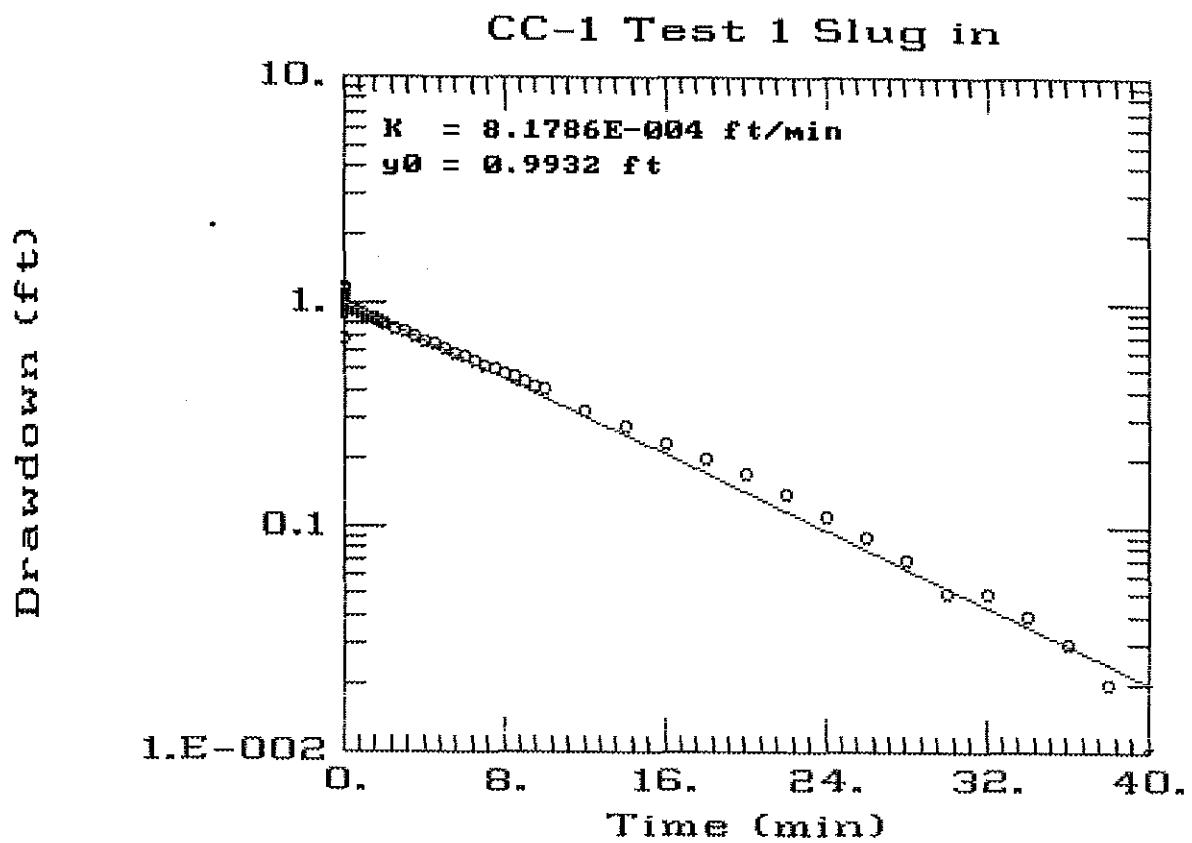


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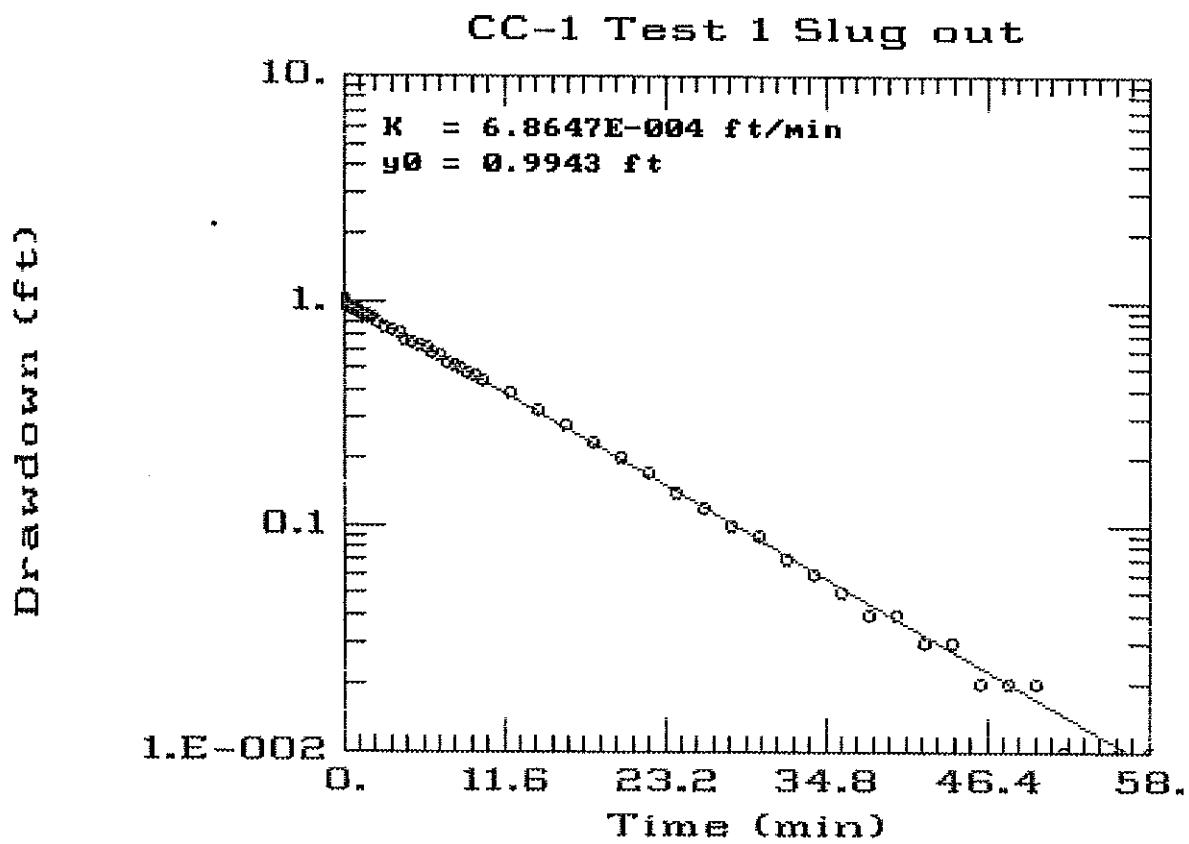
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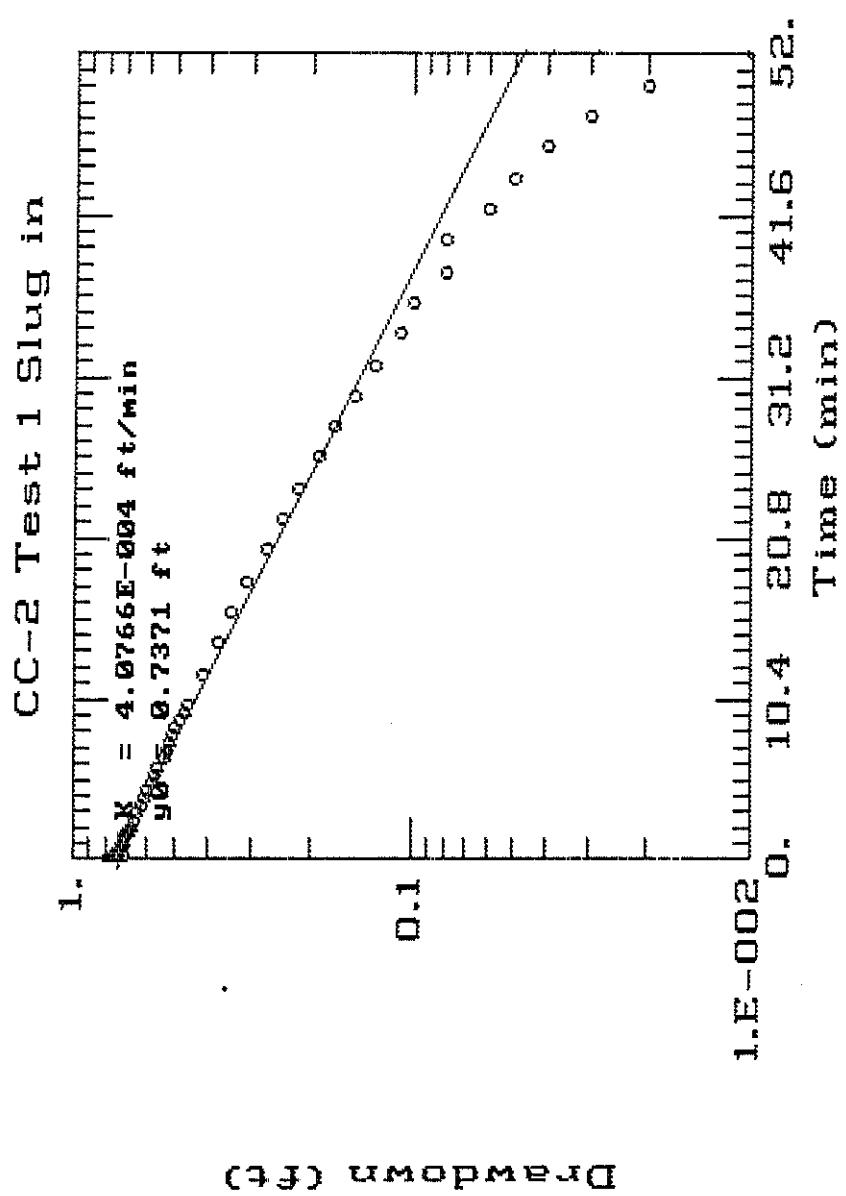
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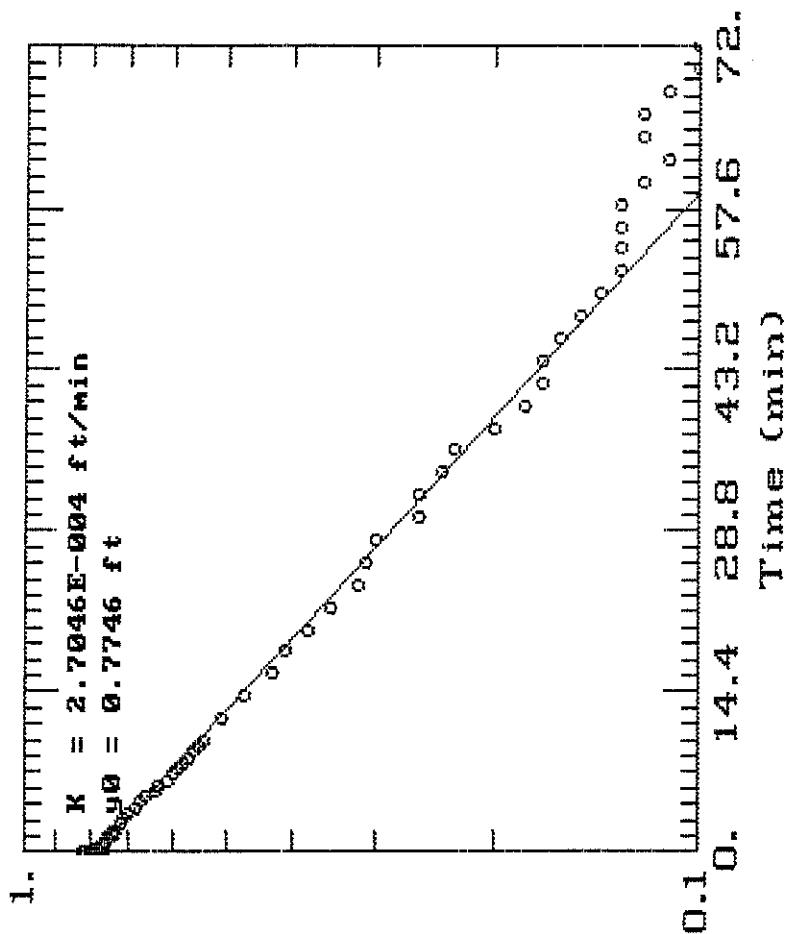
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00088



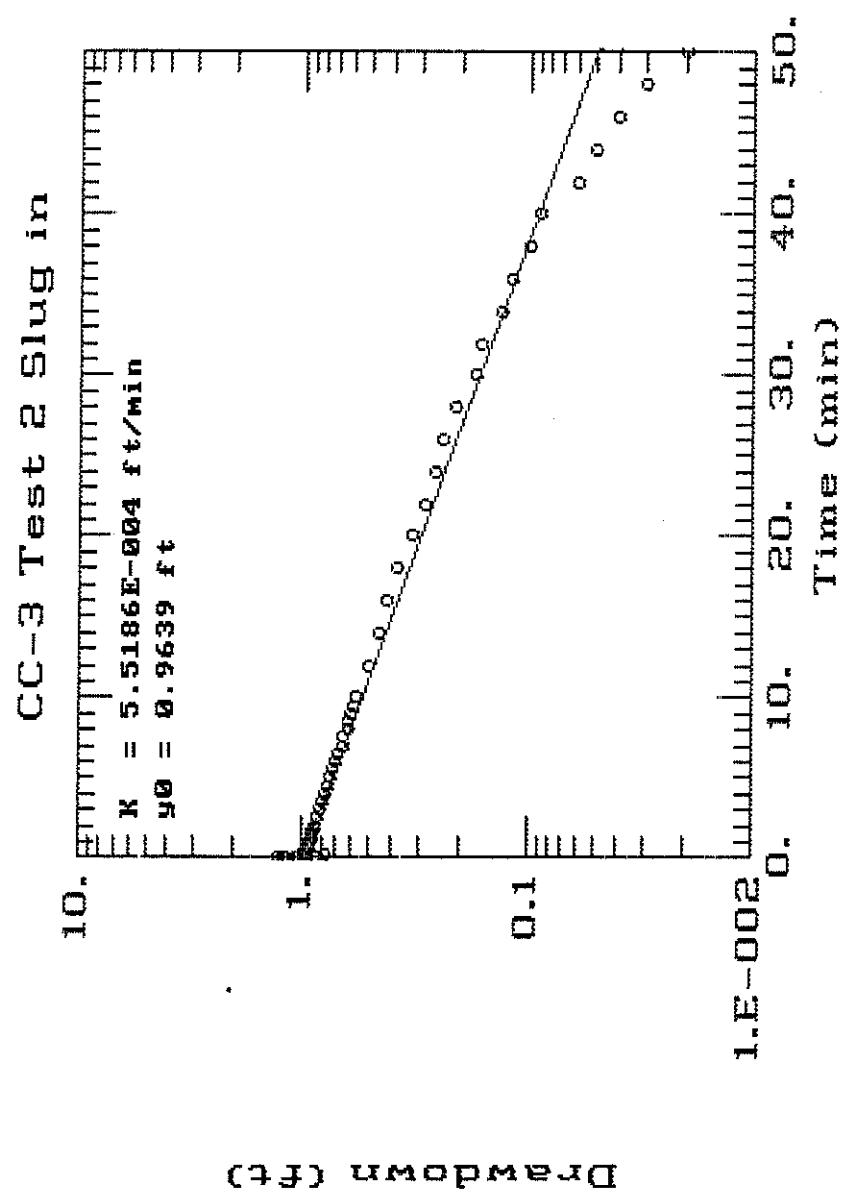
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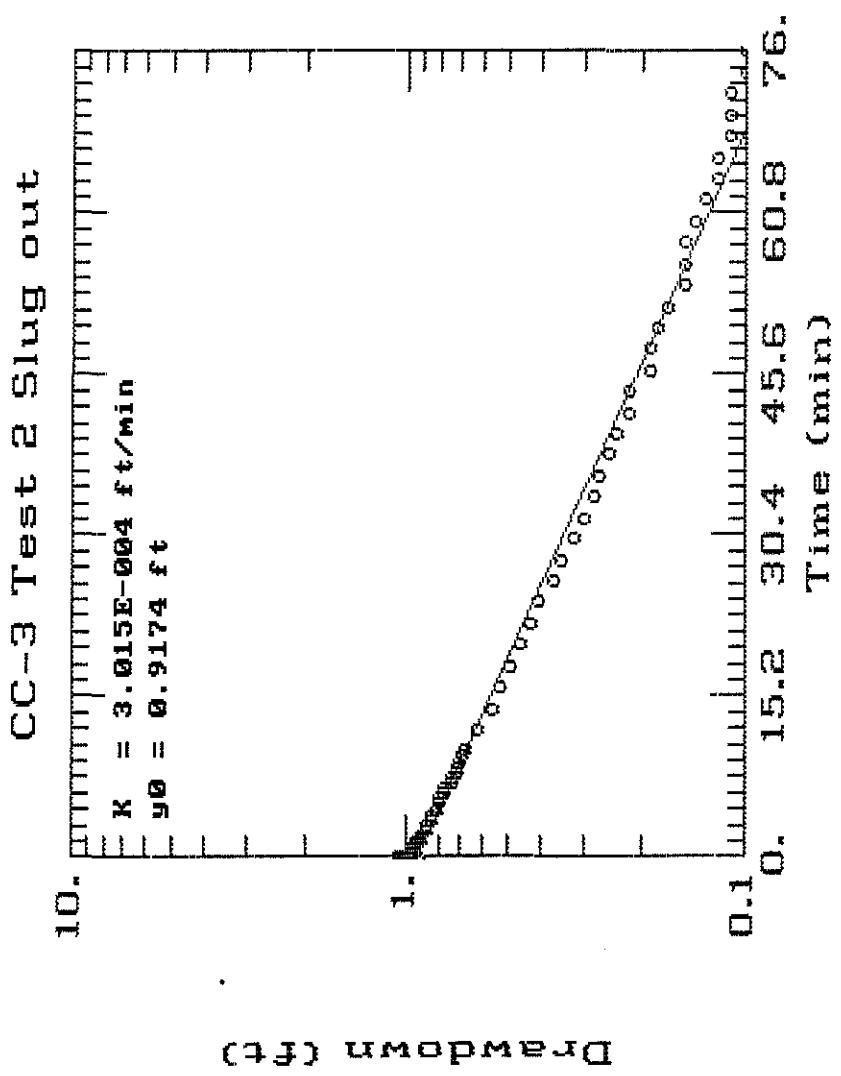
CC-2 Test 1 Slug out



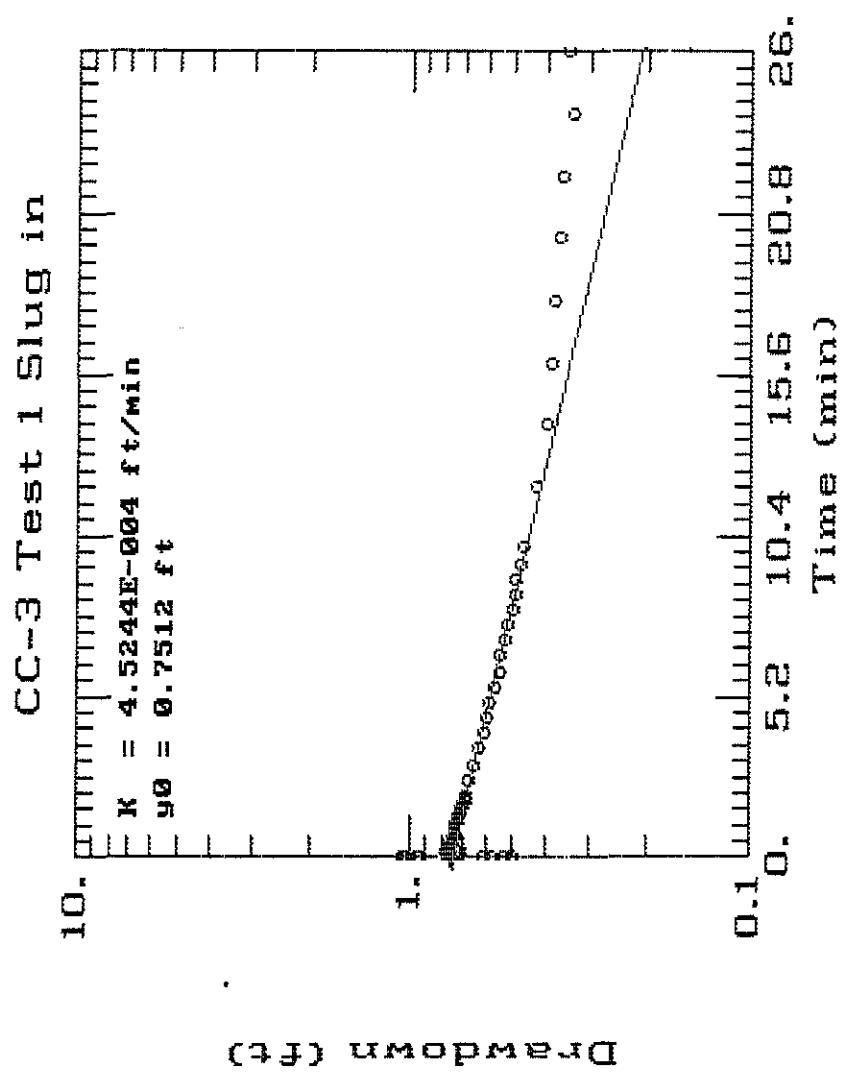
Drawdown (ft)

00089

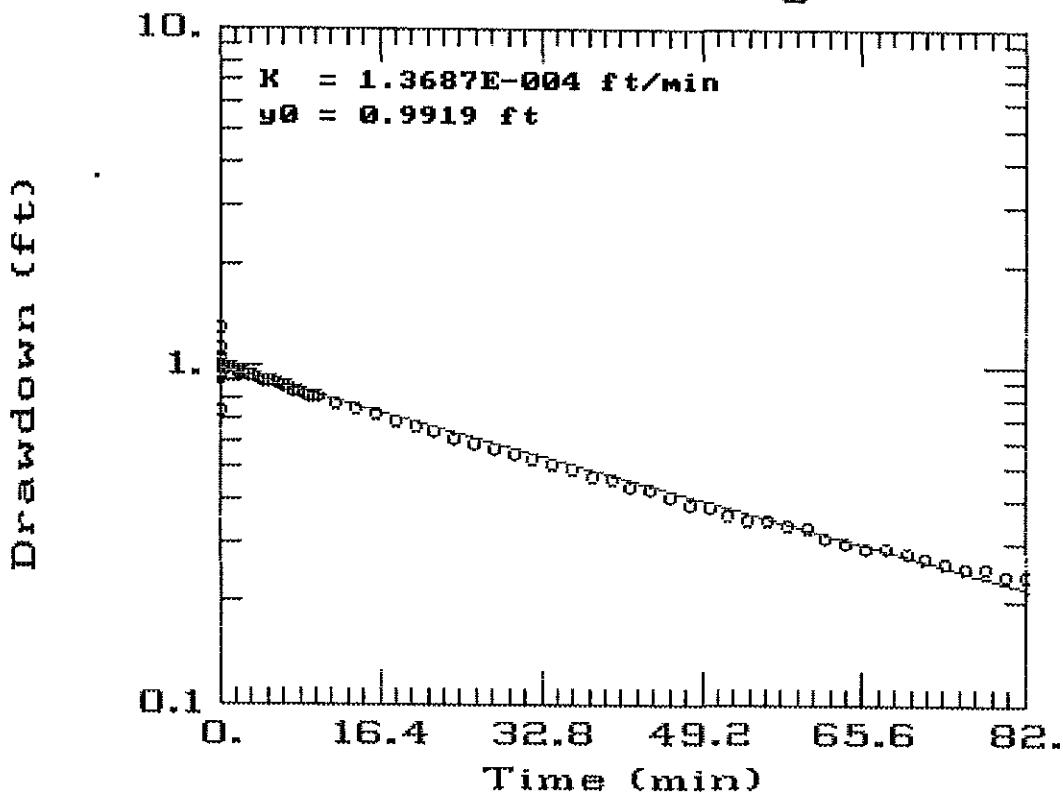




00090



CC-4 Test 1 Slug in

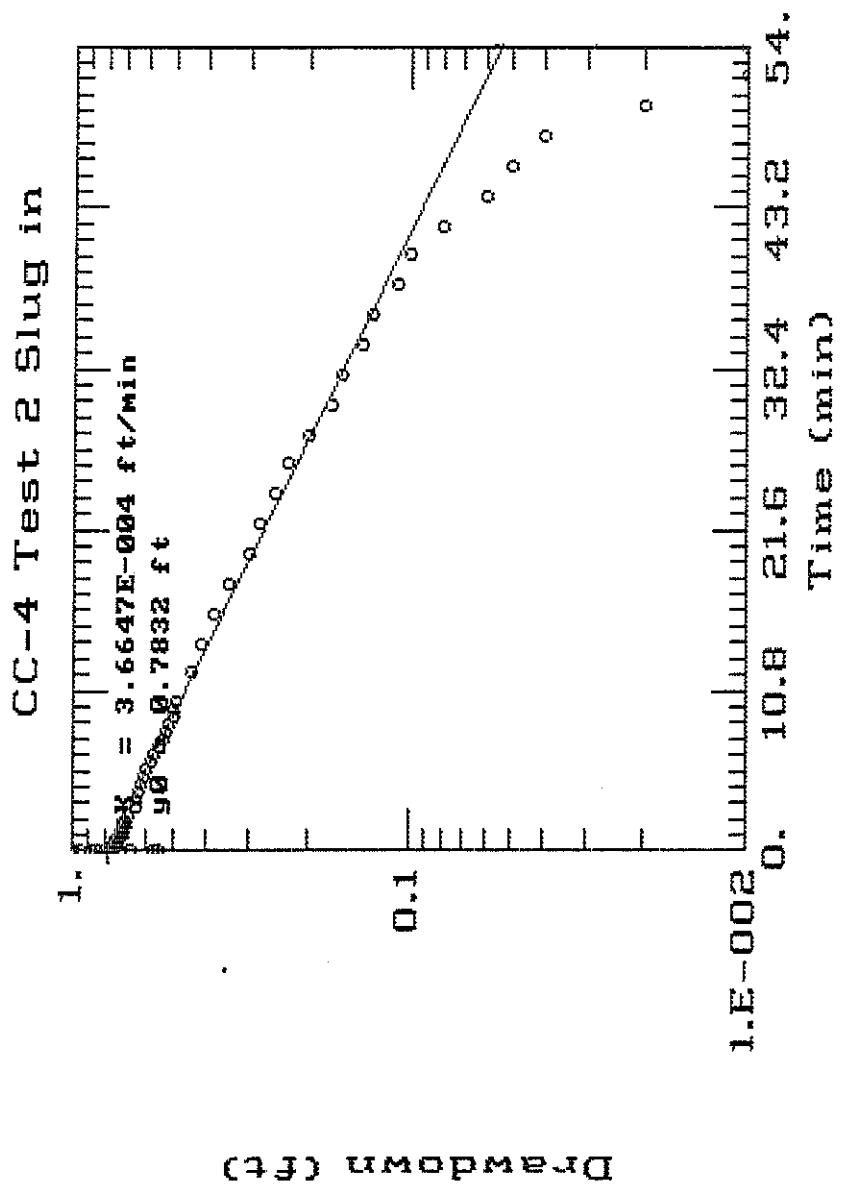


AQTESOLV



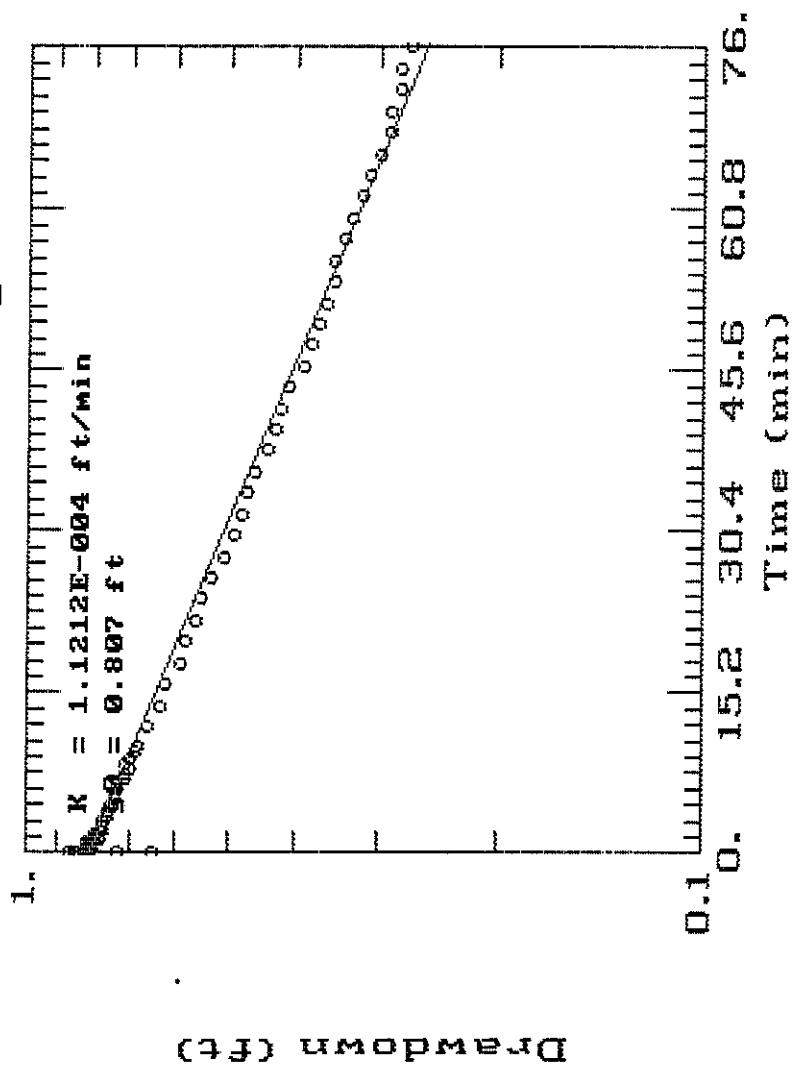
16000
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00092

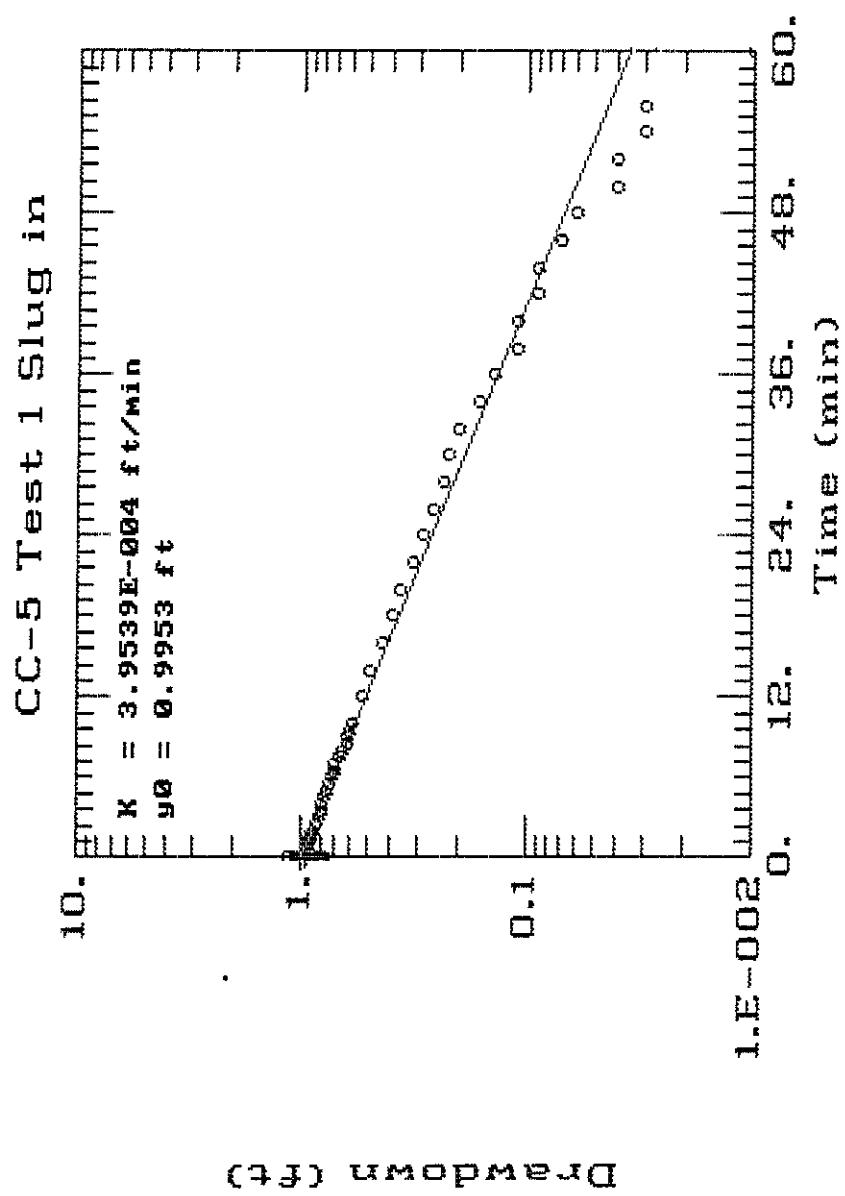


00093

CC-4 Test 2 Slug out

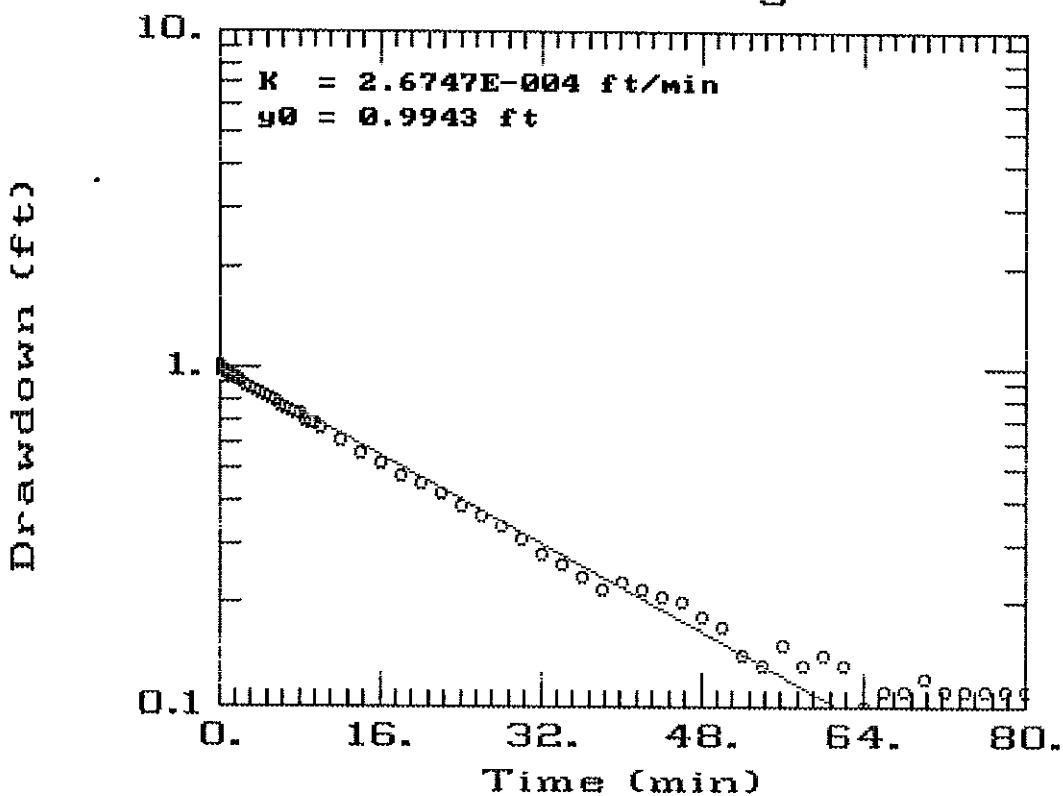


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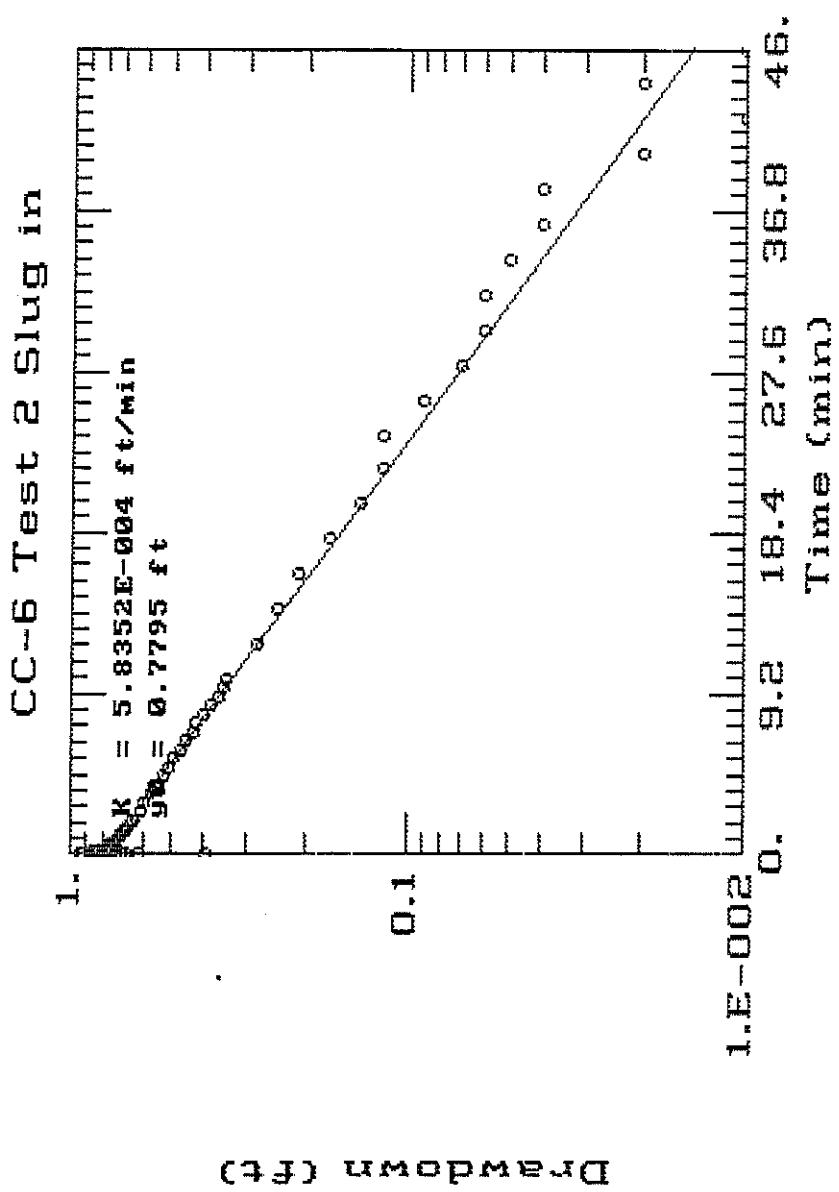


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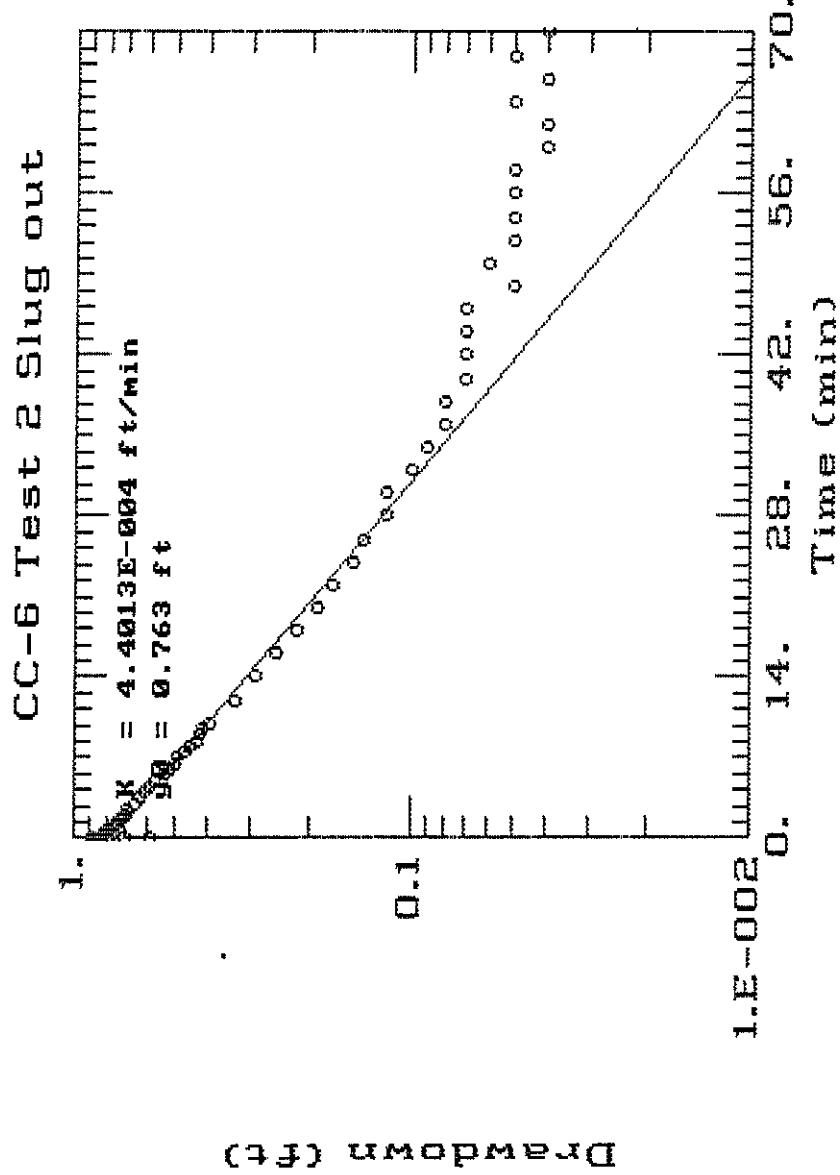
CC-5 Test 1 Slug out

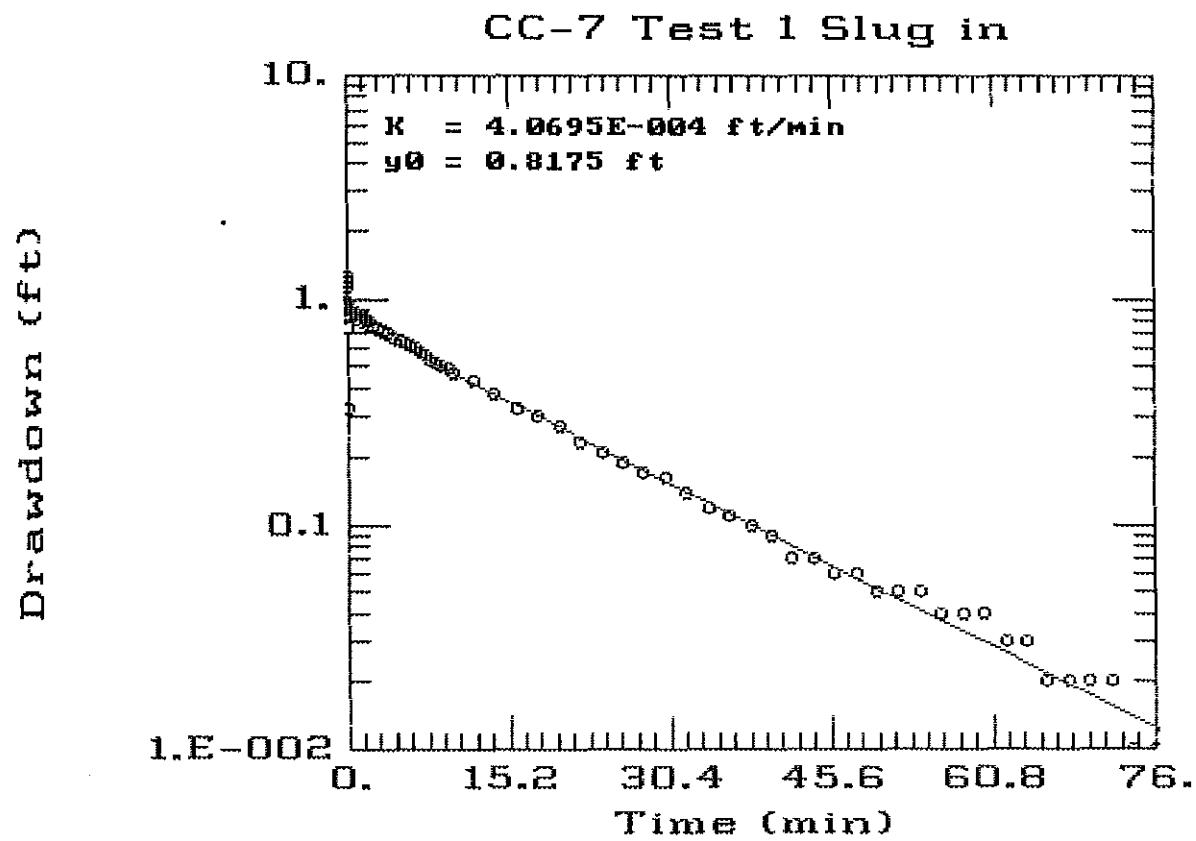


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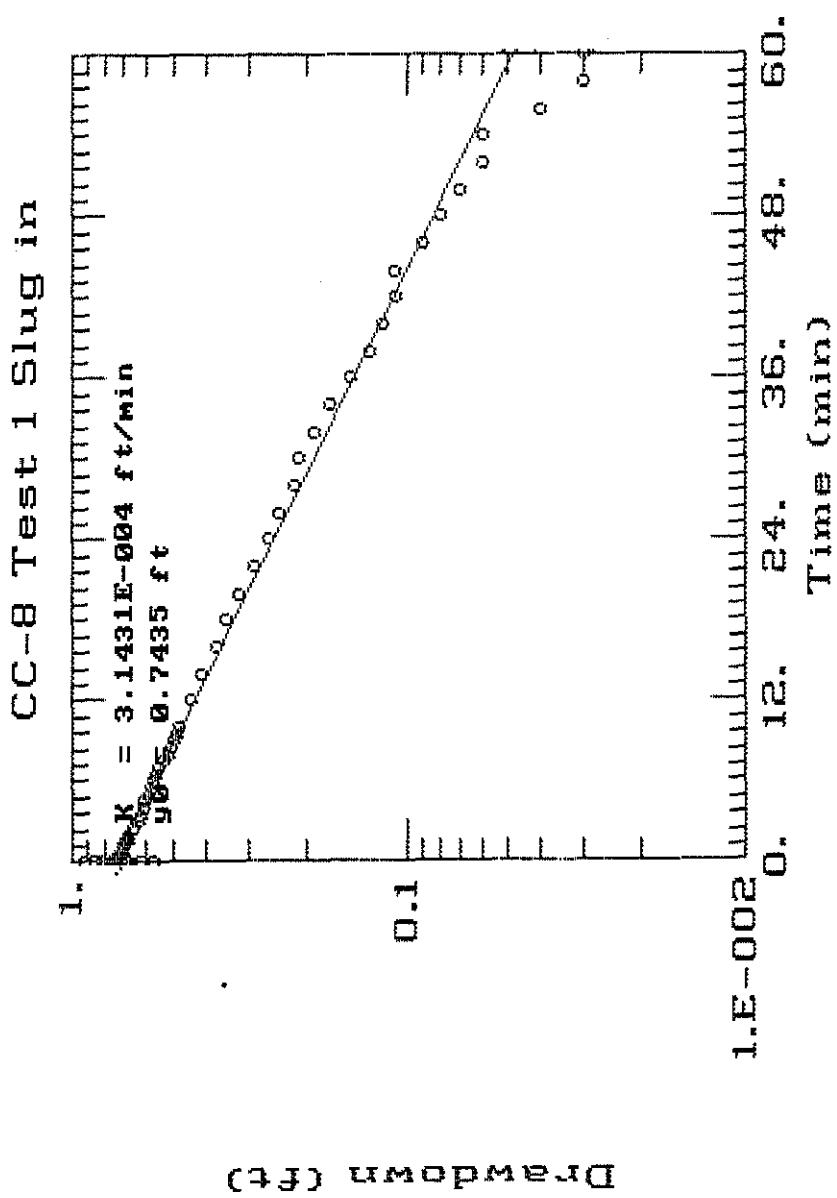
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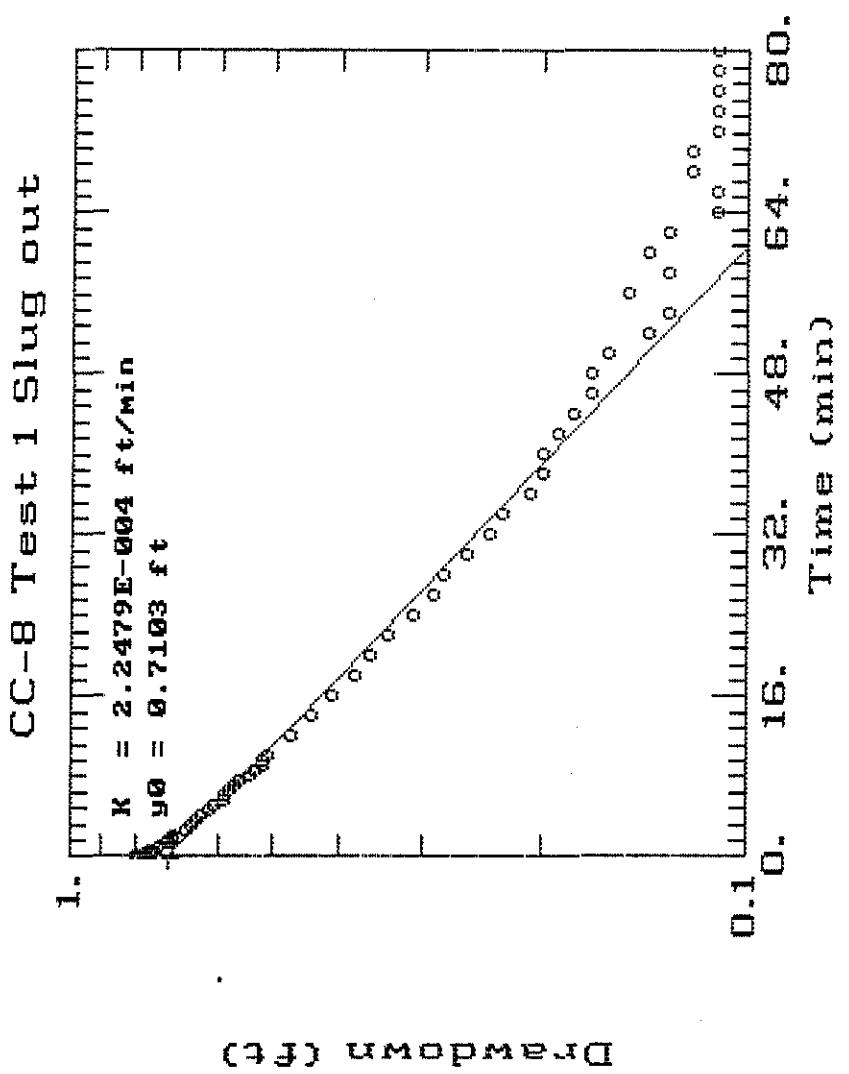


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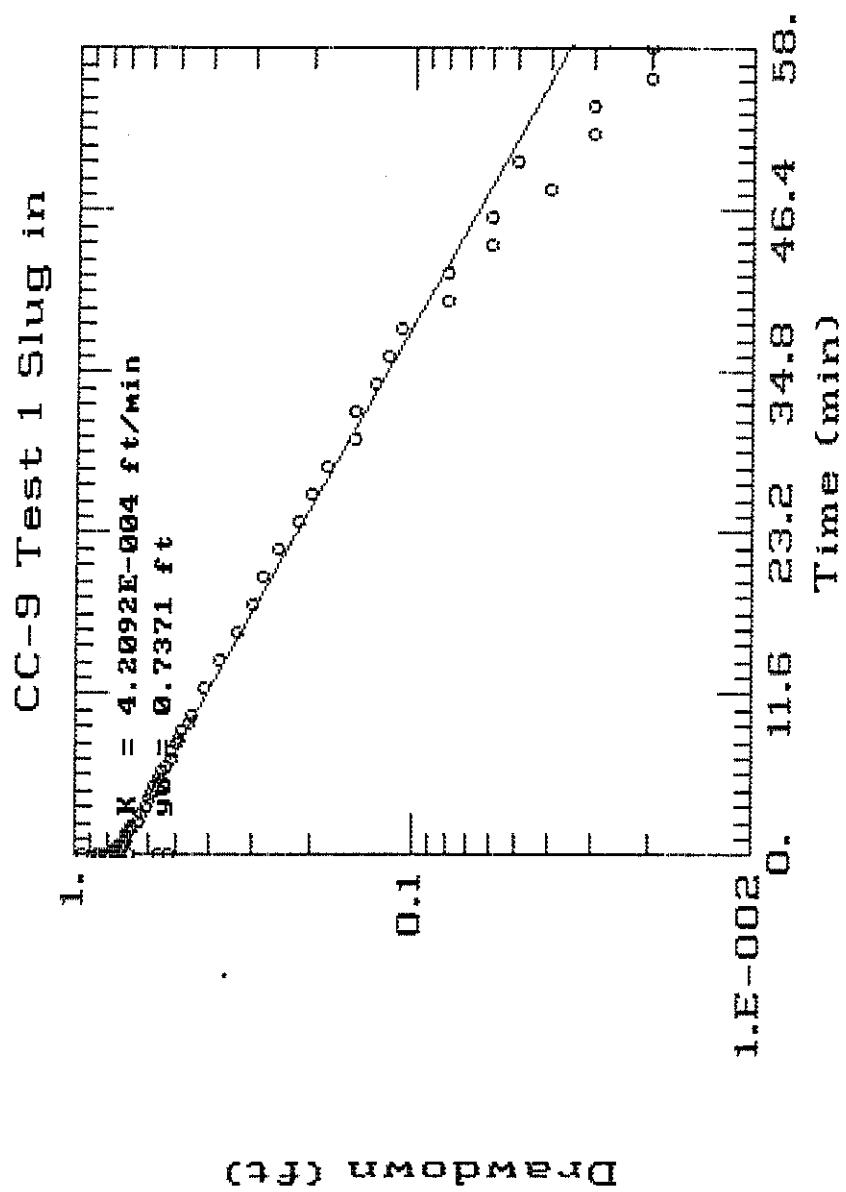
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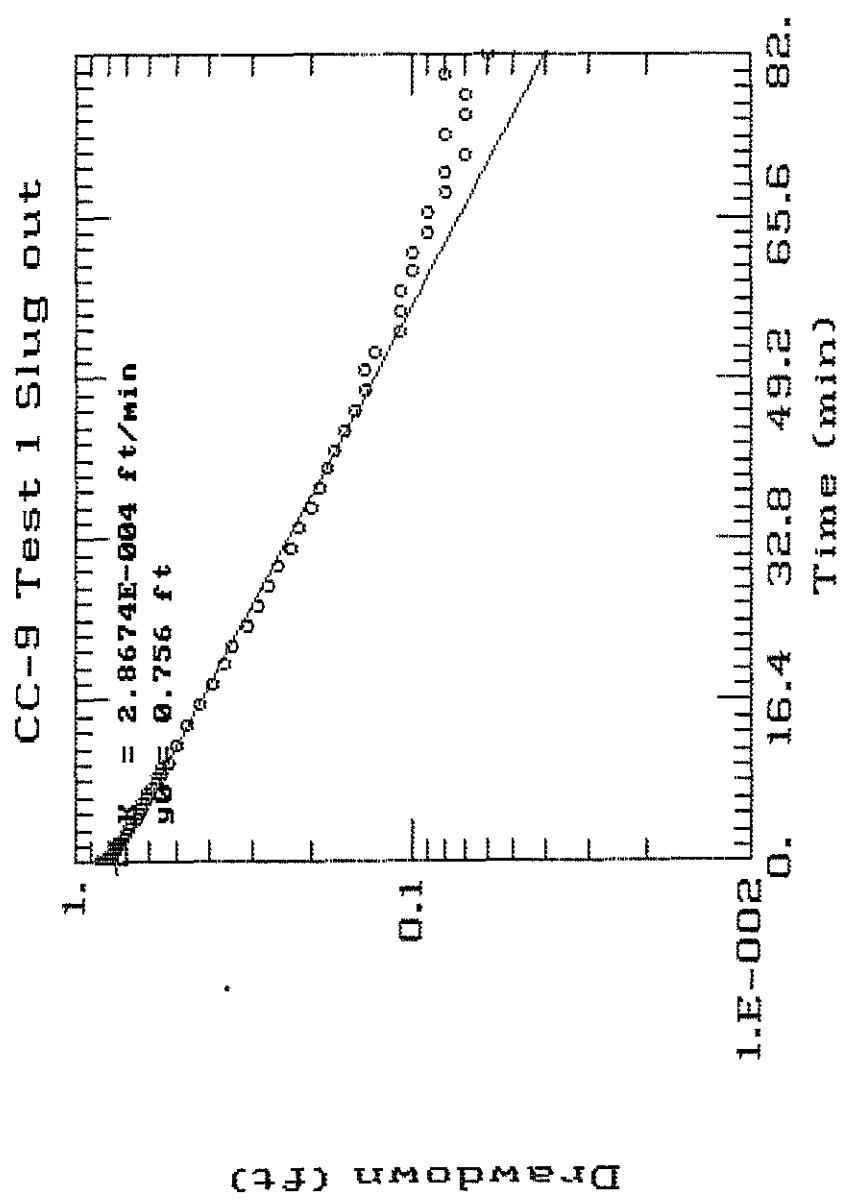
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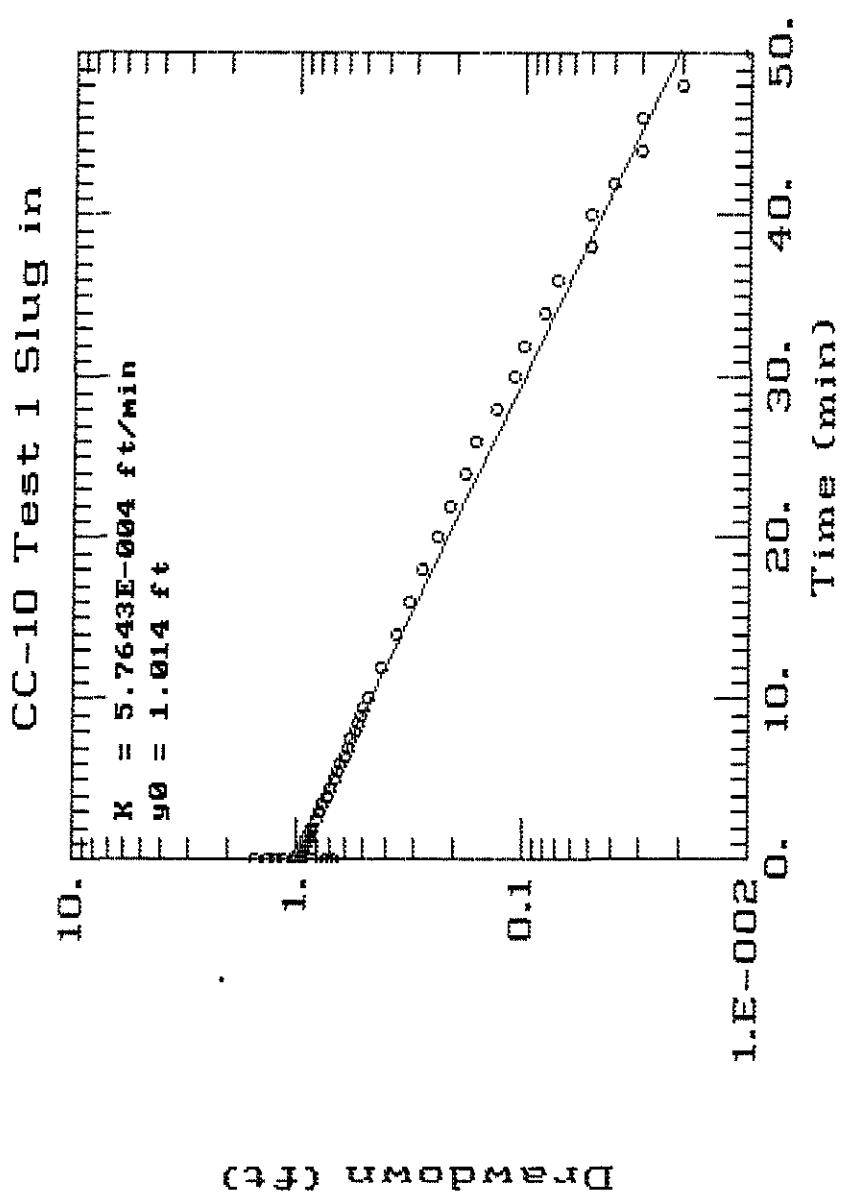
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00102

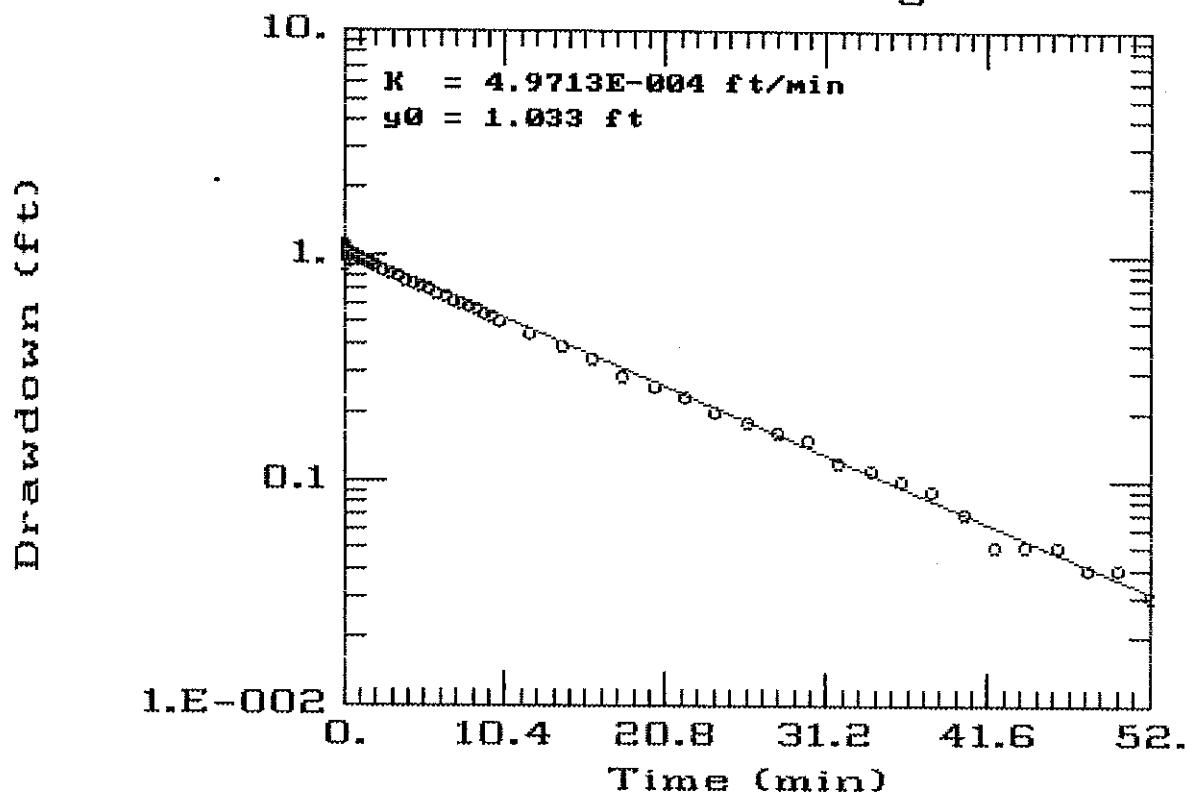


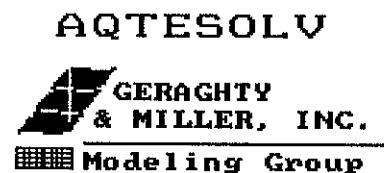
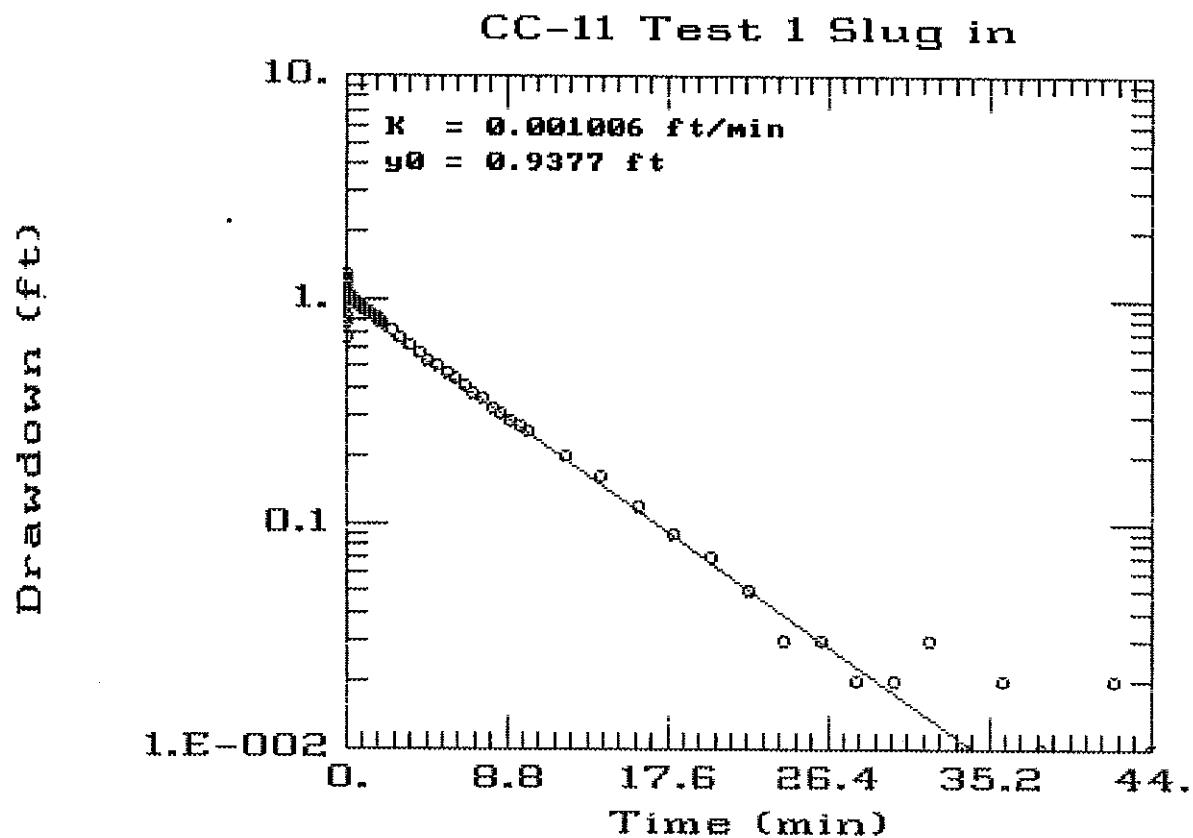
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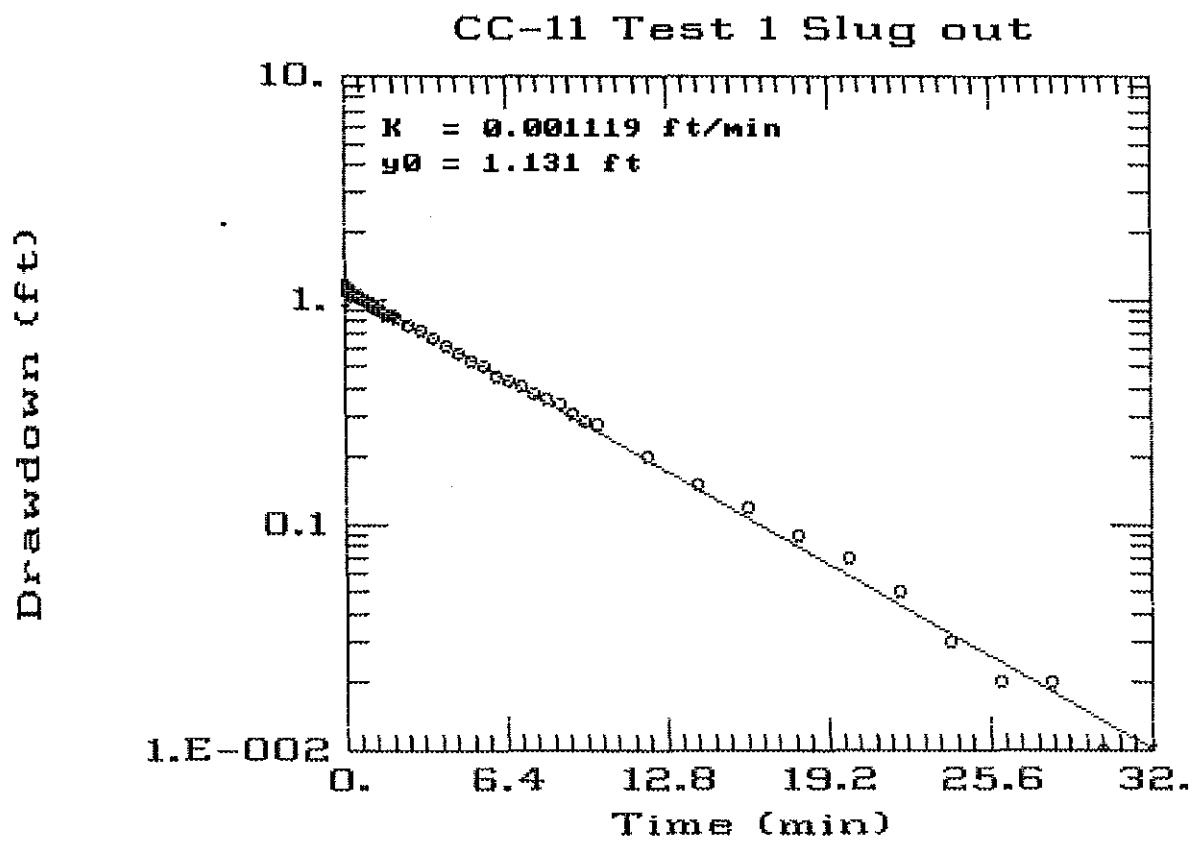
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CC-10 Test 1 Slug out





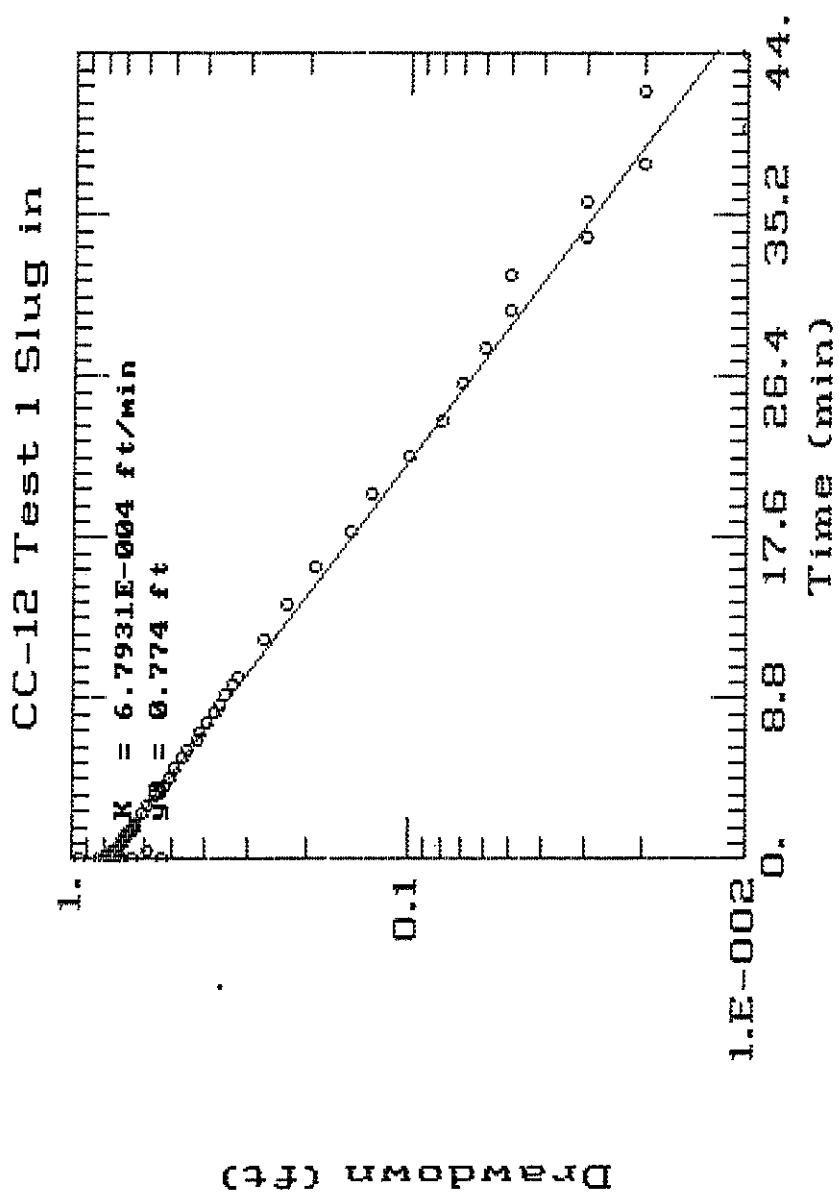
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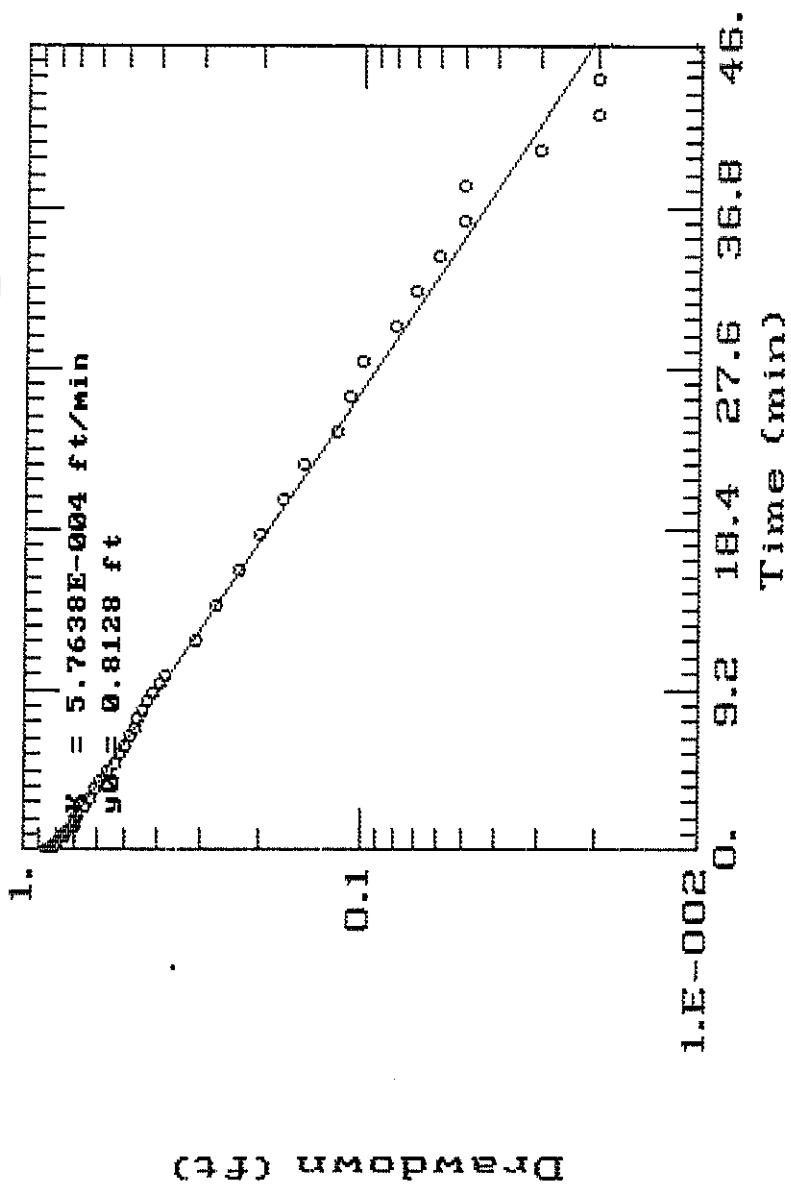
90T00

00107

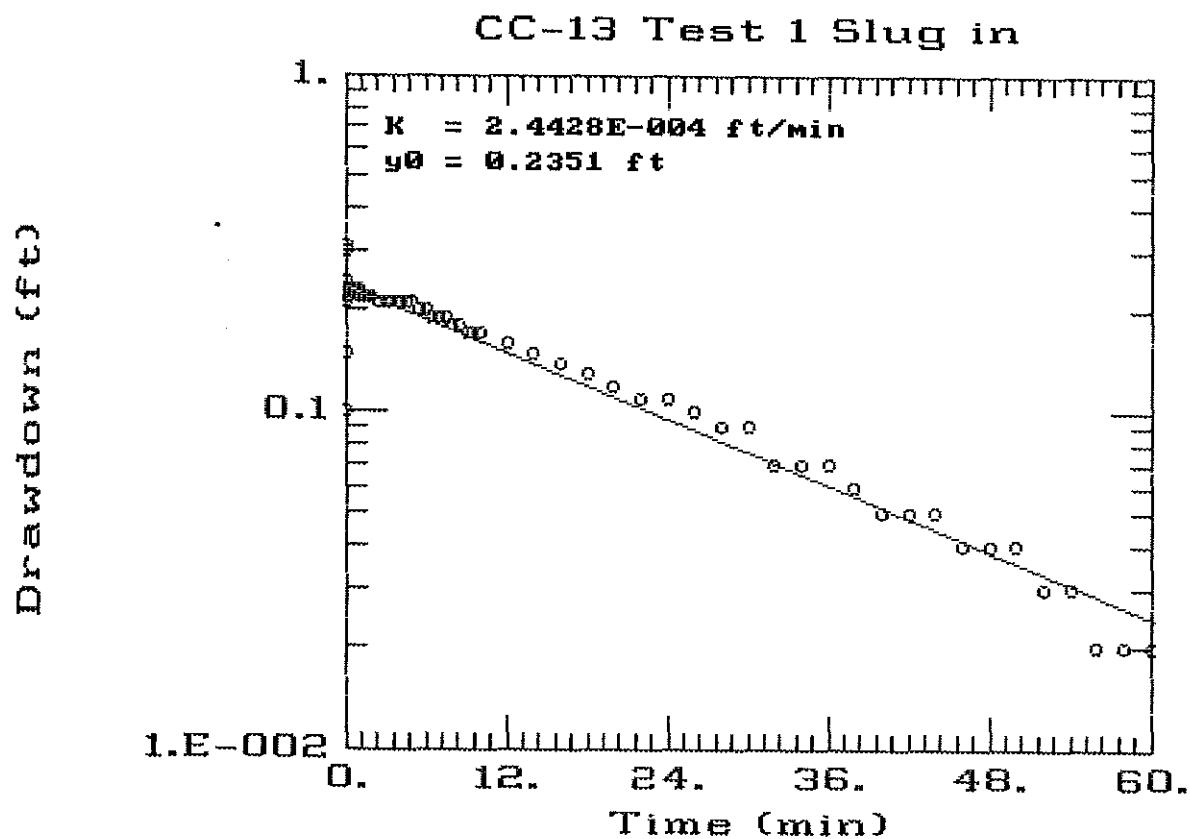


00108

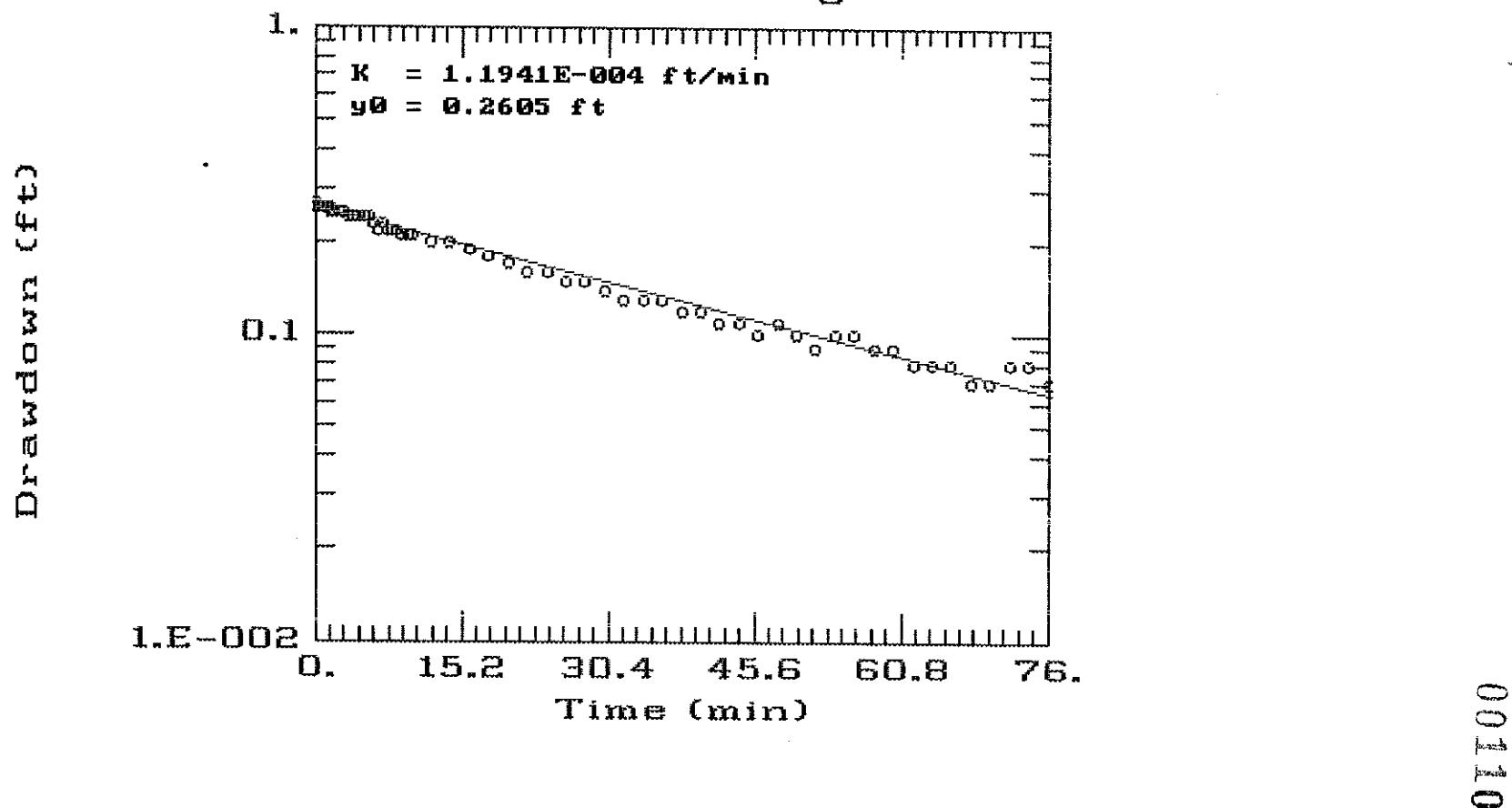
CC-12 Test 1 Slug out



60T60

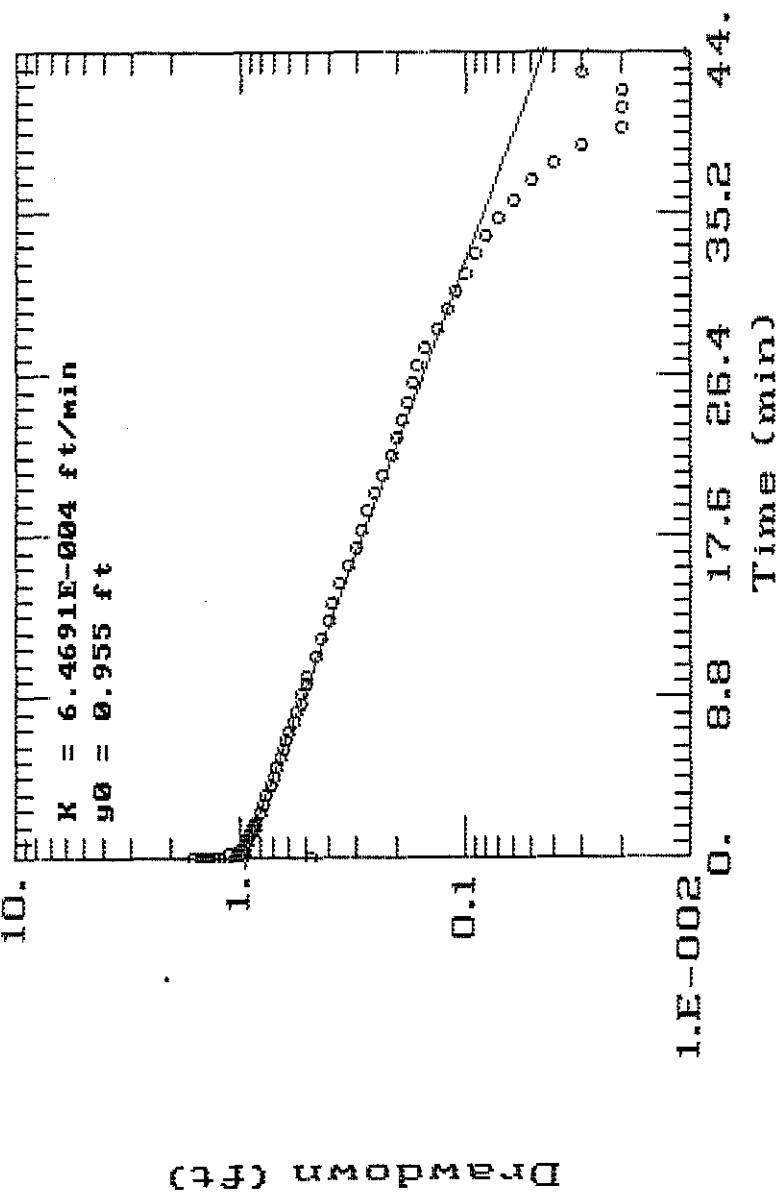


CC-13 Test 1 Slug out

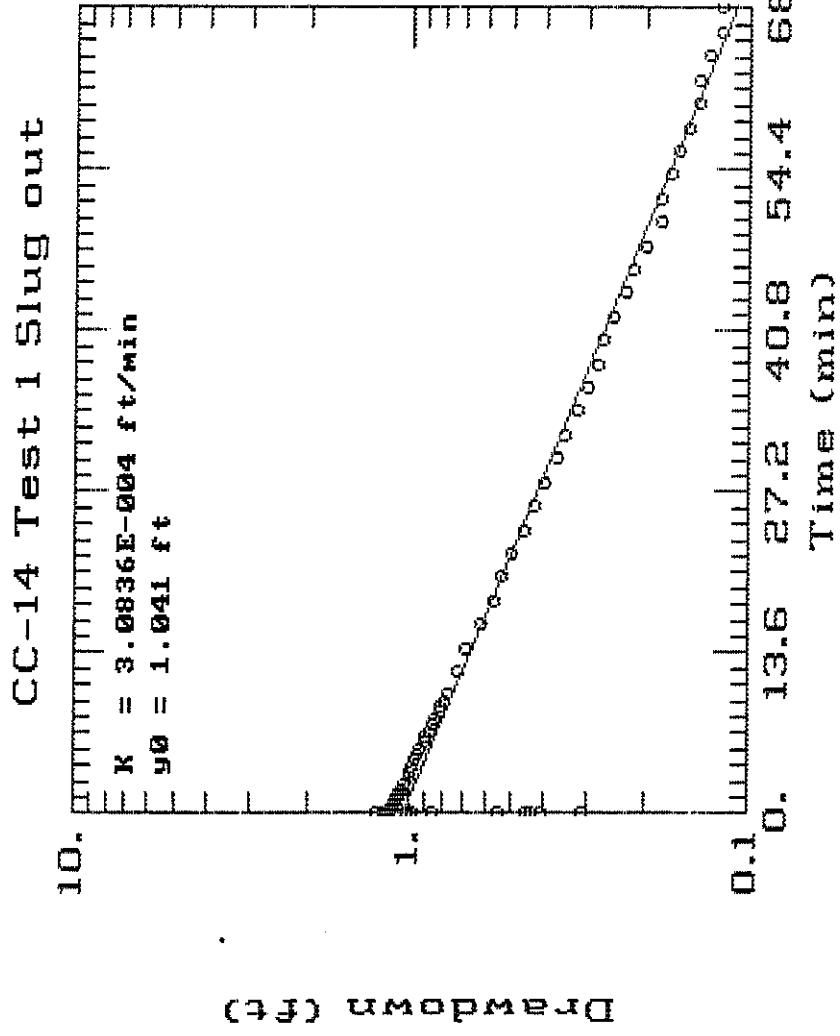


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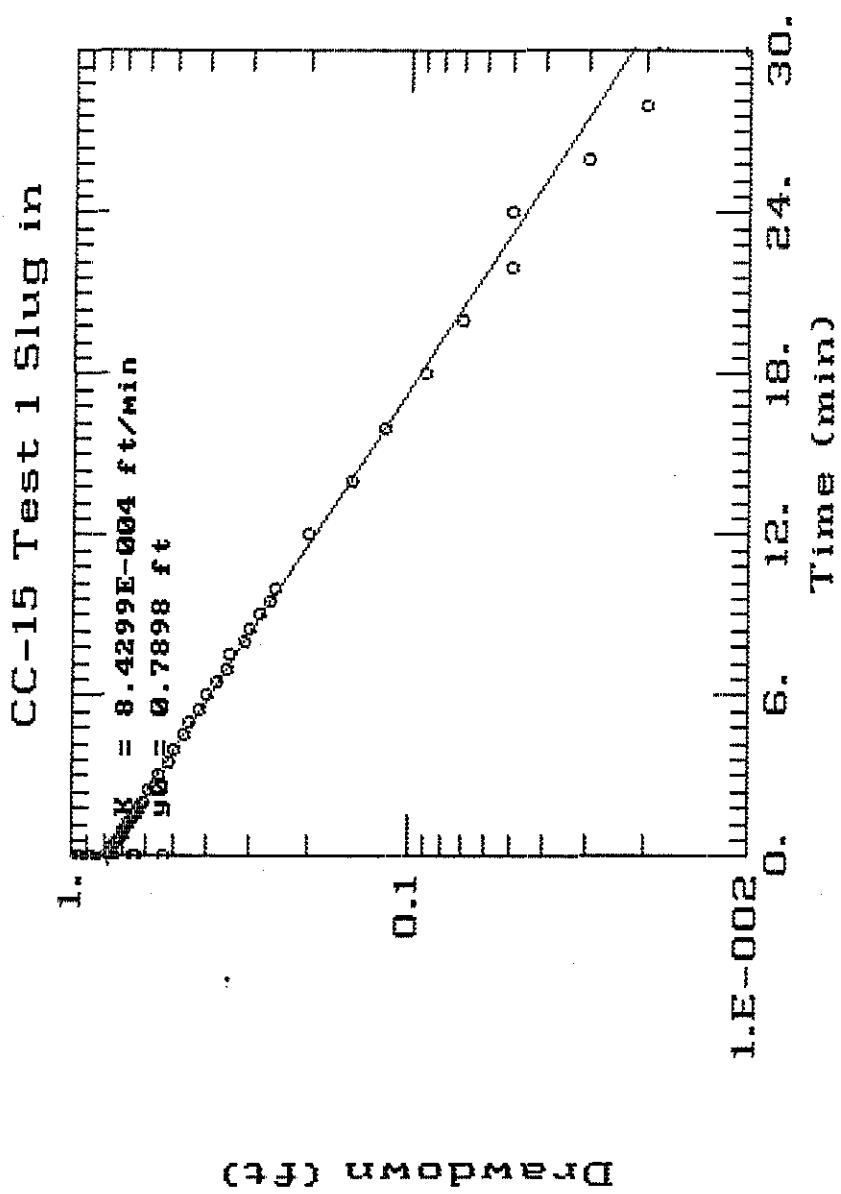
CC-14 Test 1 Slug in



00112

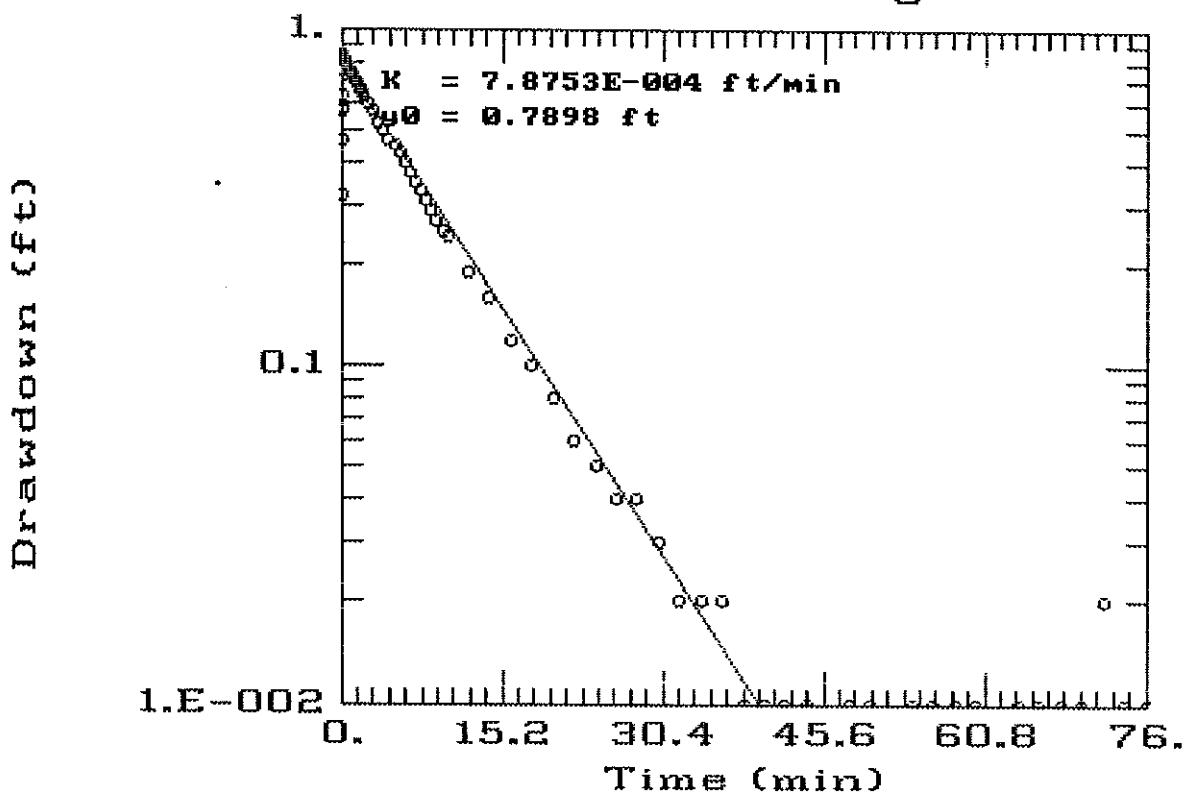


00113



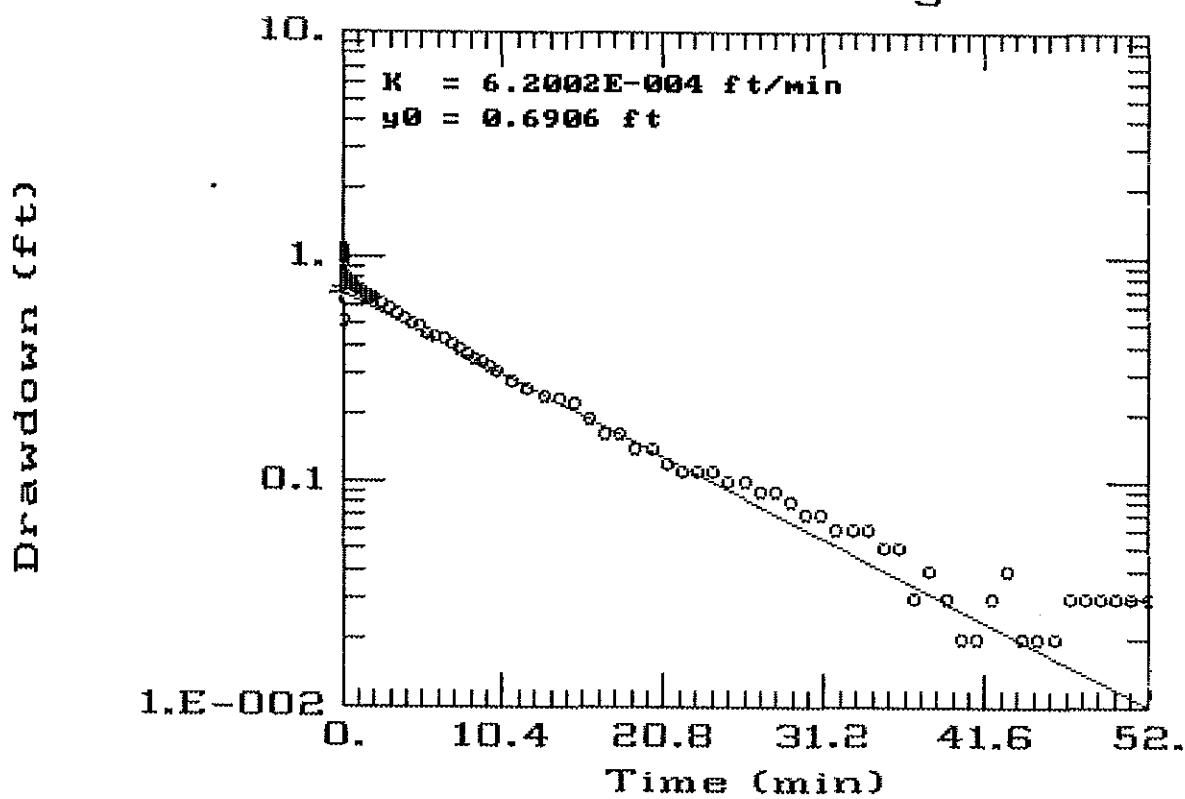
00114

CC-15 Test 1 Slug out



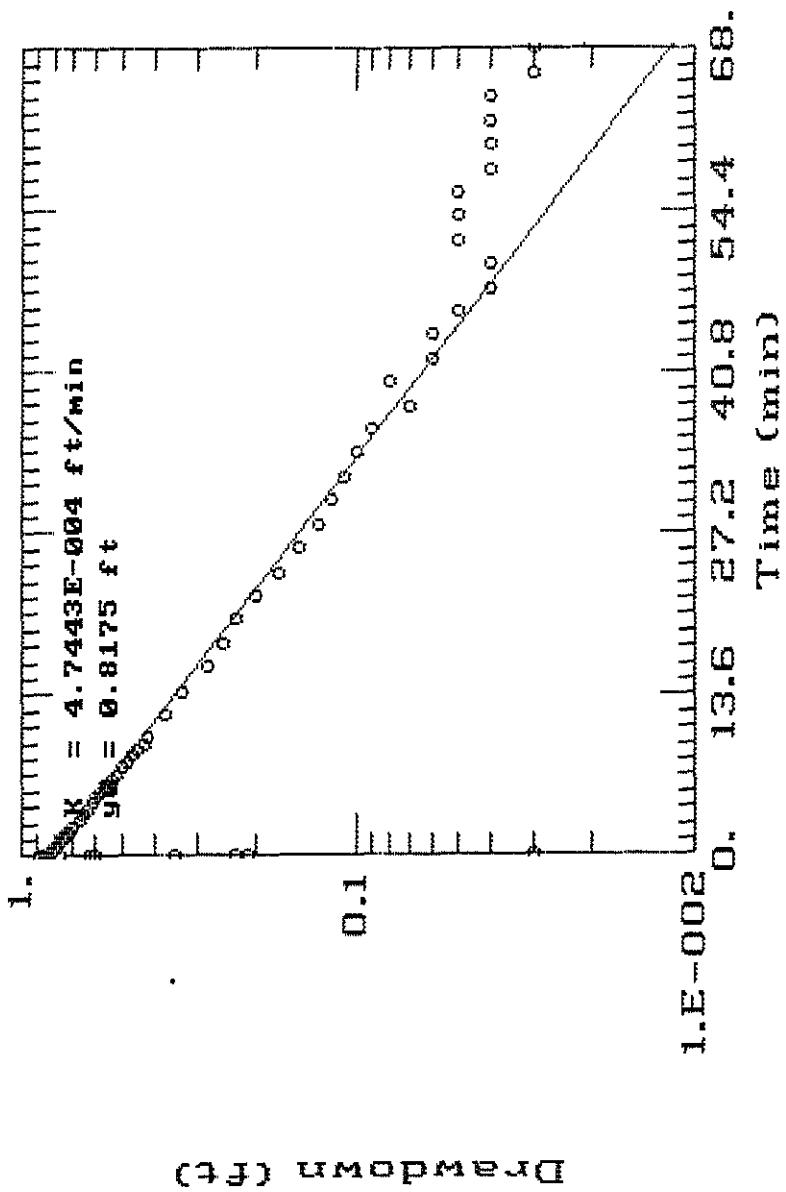
54100

CC-16 Test 1 Slug in

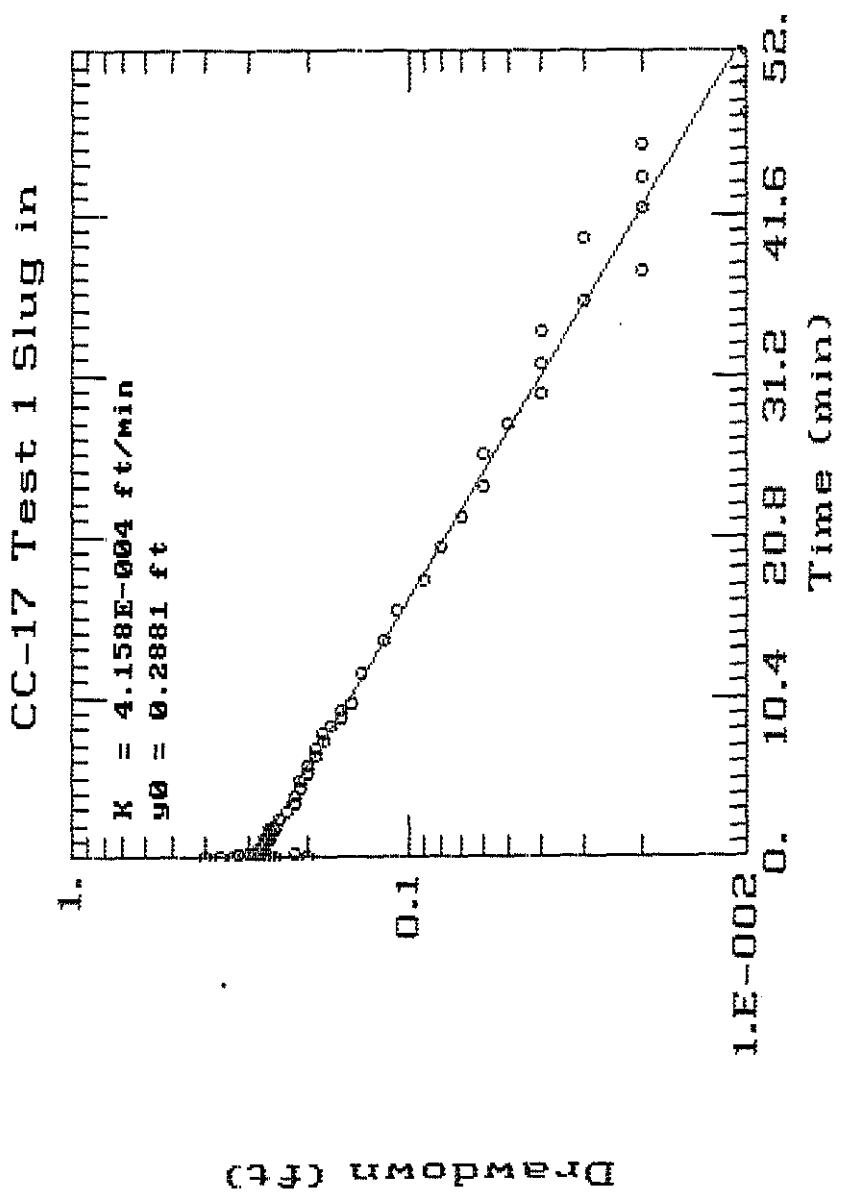


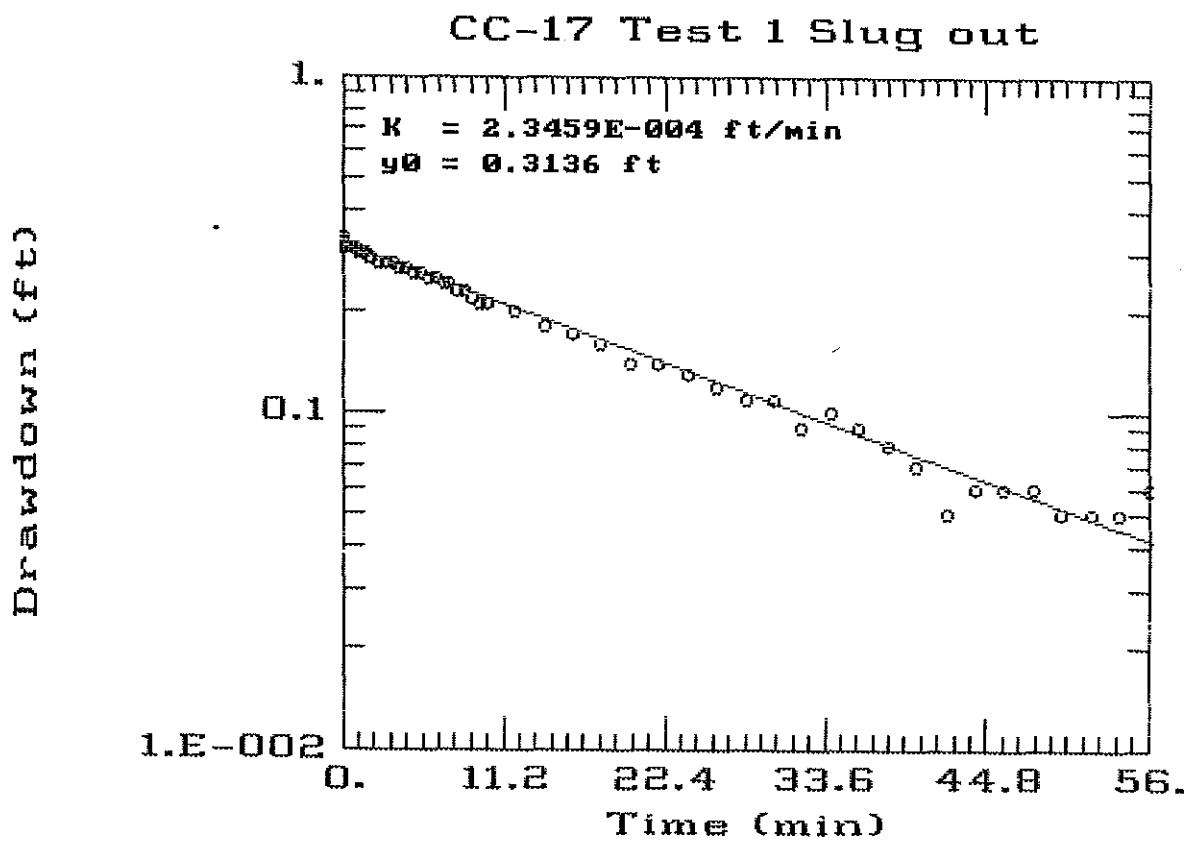
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CC-16 Test 1 Slug out

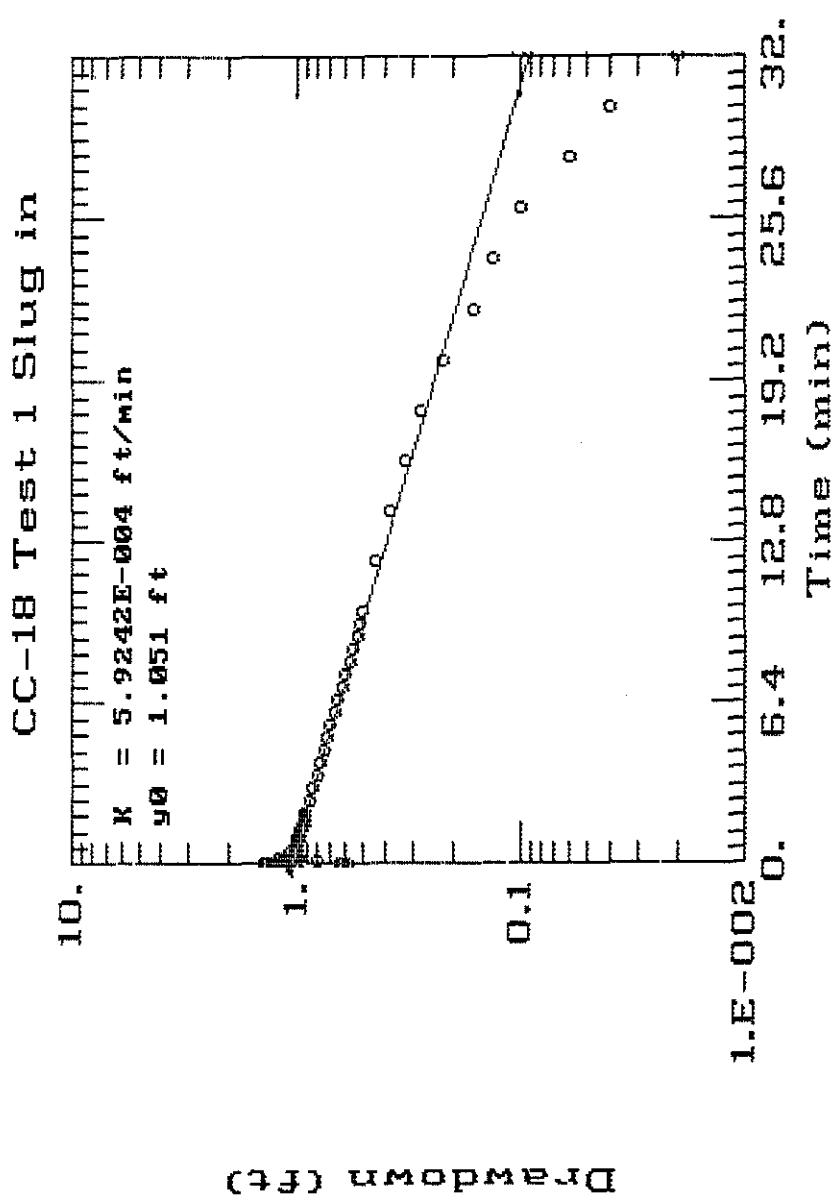


00117



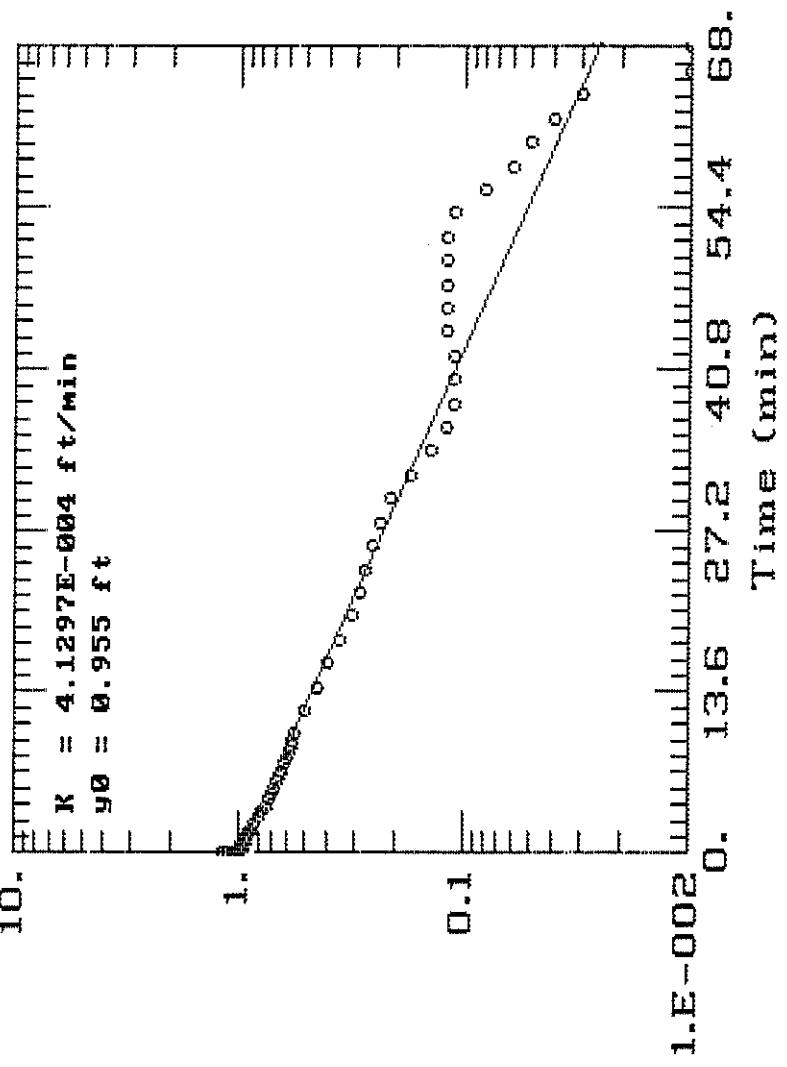


00119



00120

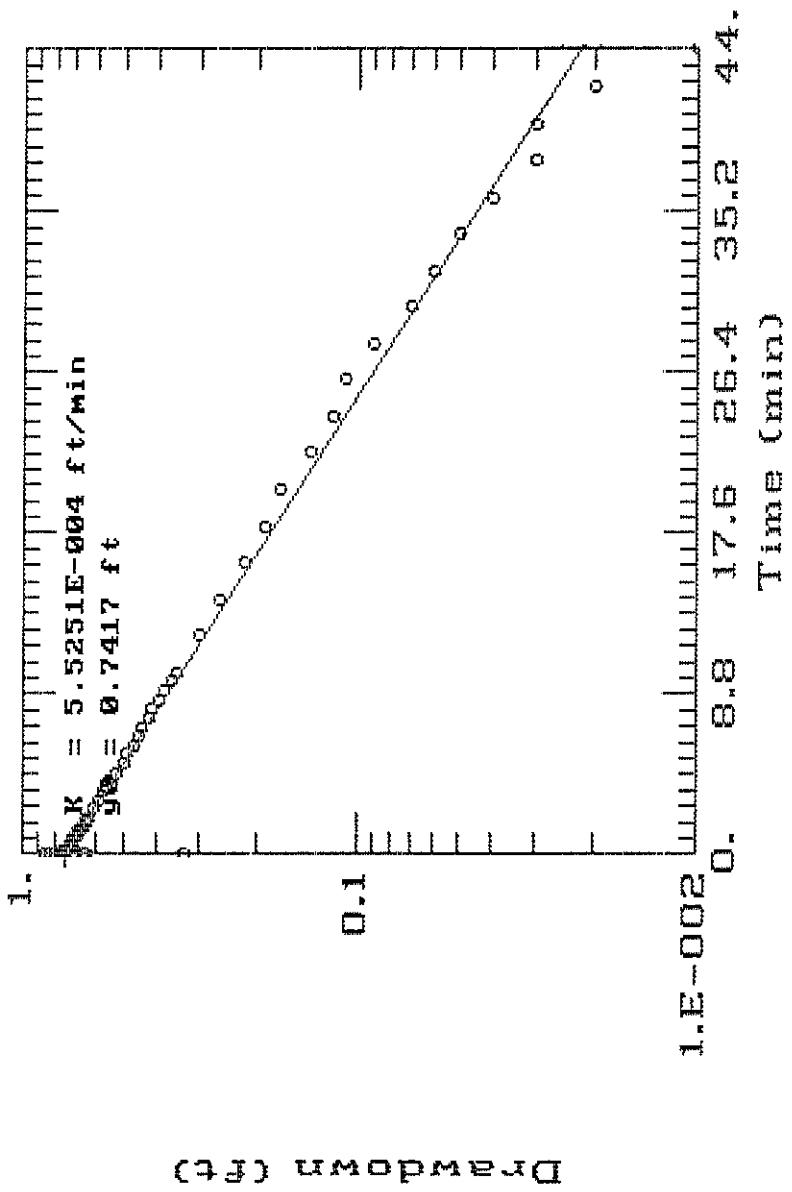
CC-18 Test 1 Slug out



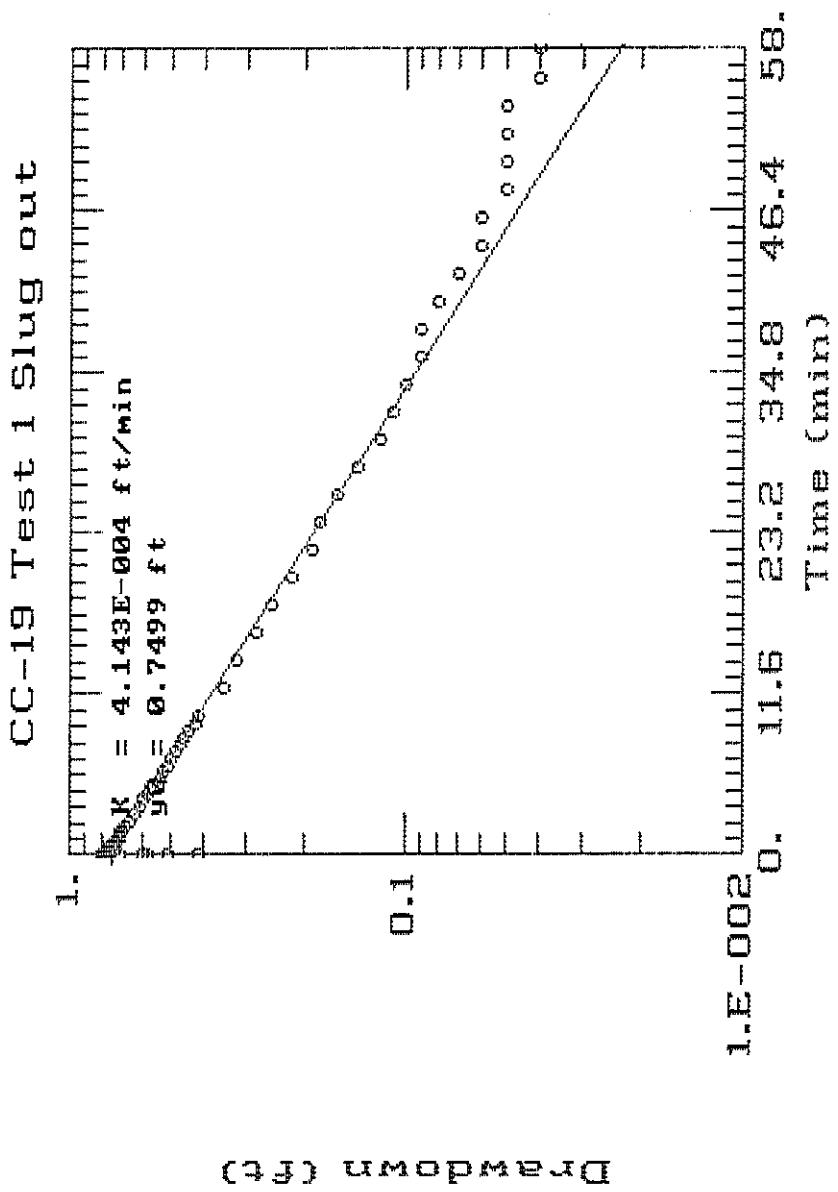
Drawdown (ft)

00121

CC-19 Test 1 Slug in

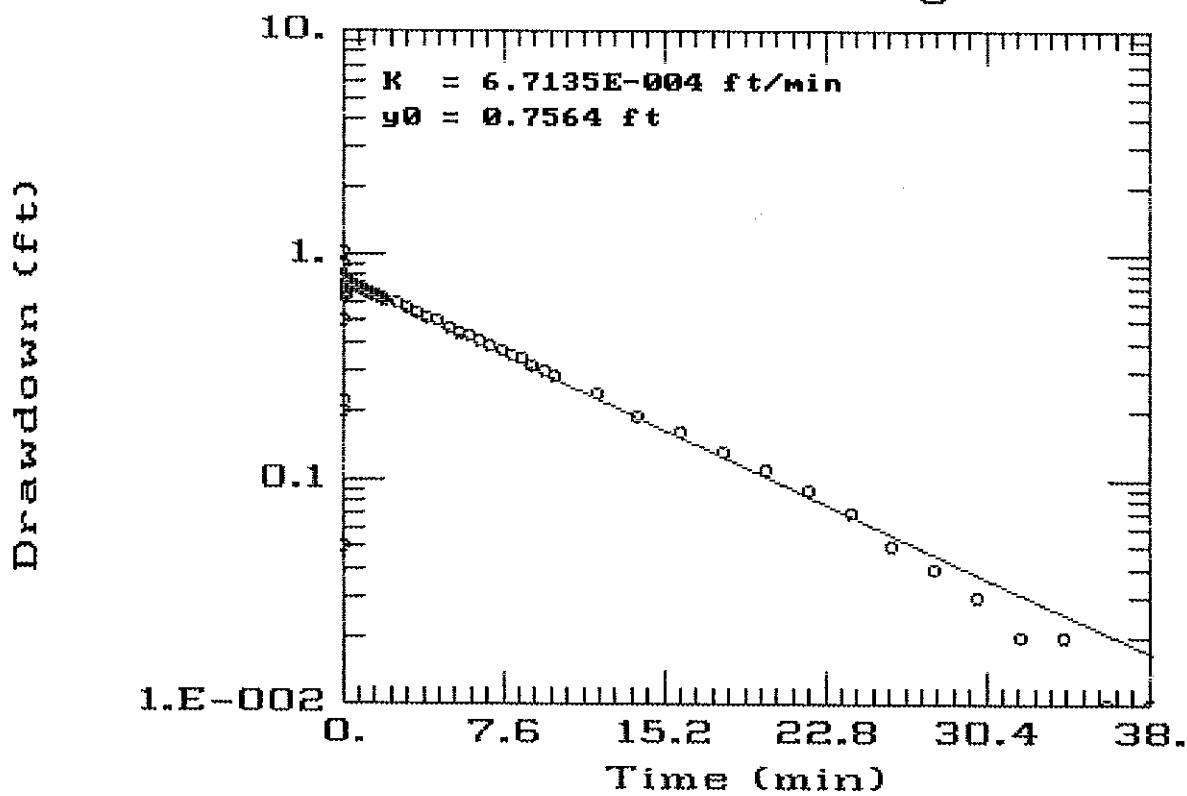


00122



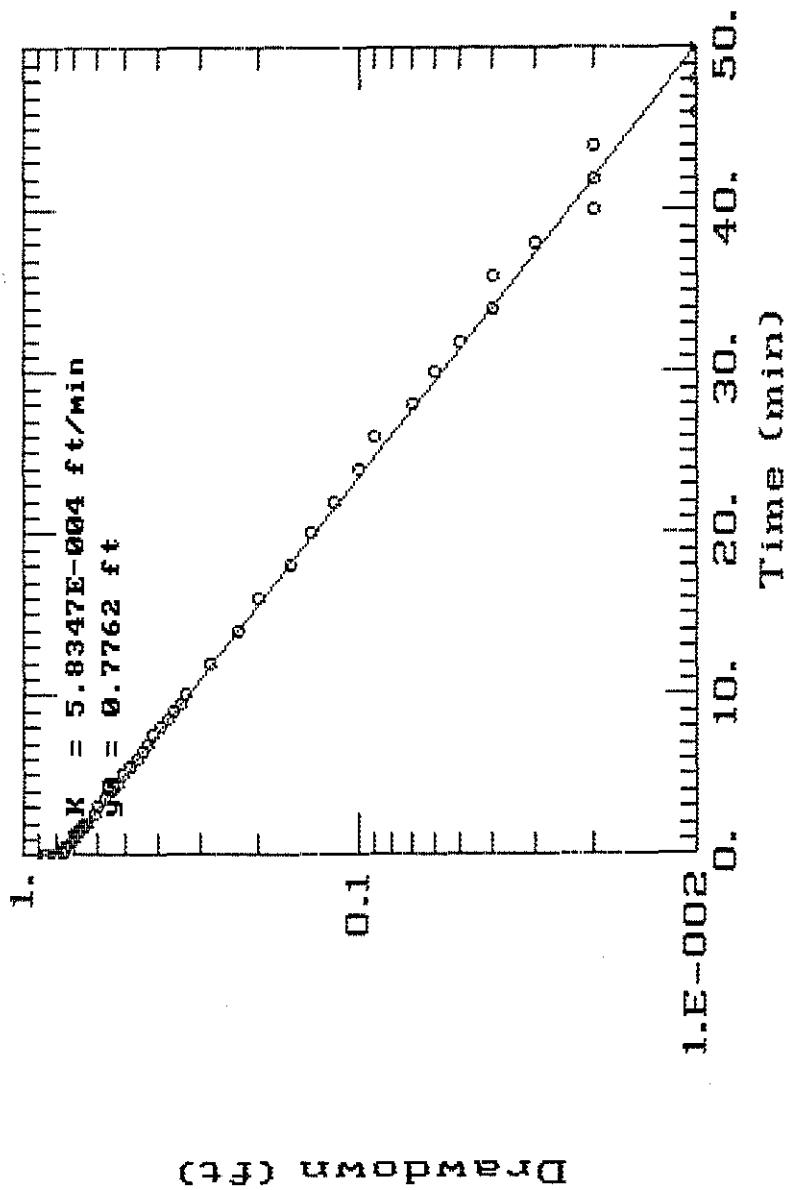
00423

CC-20 Test 1 Slug in

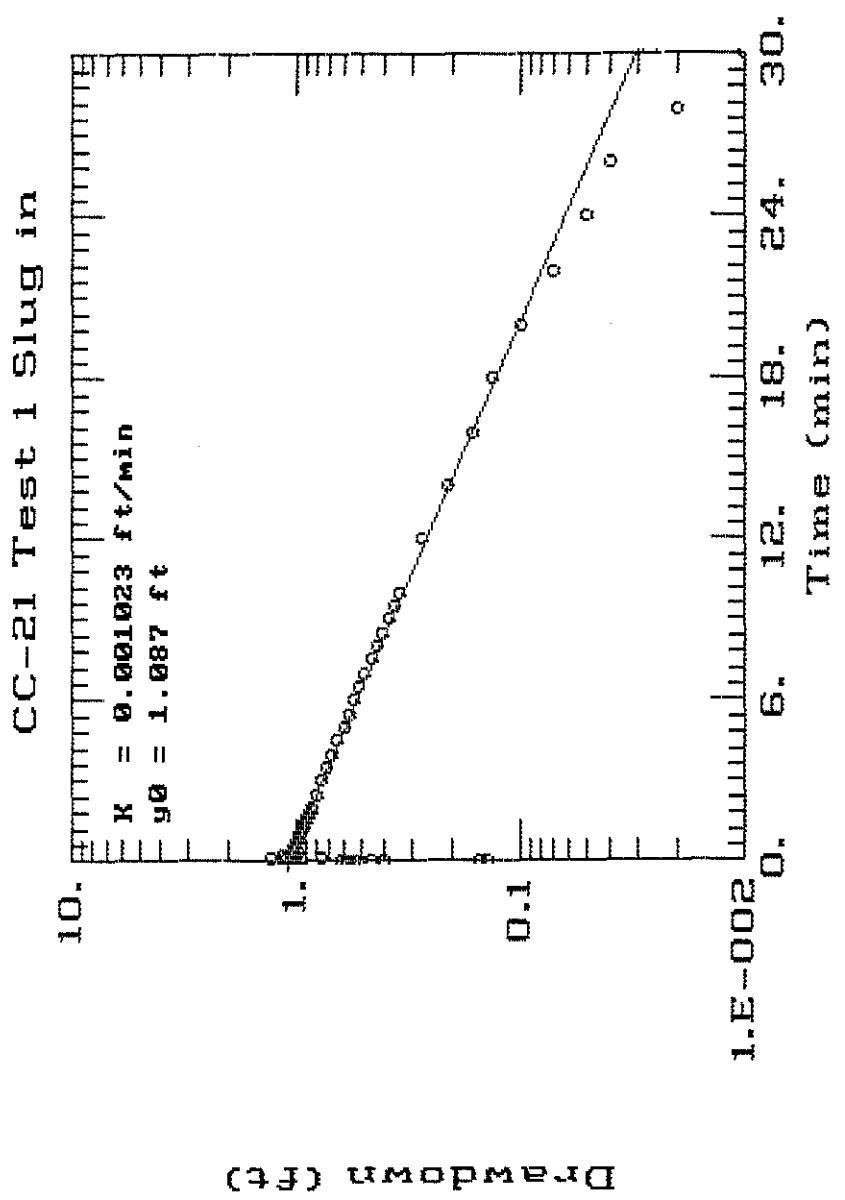


00124

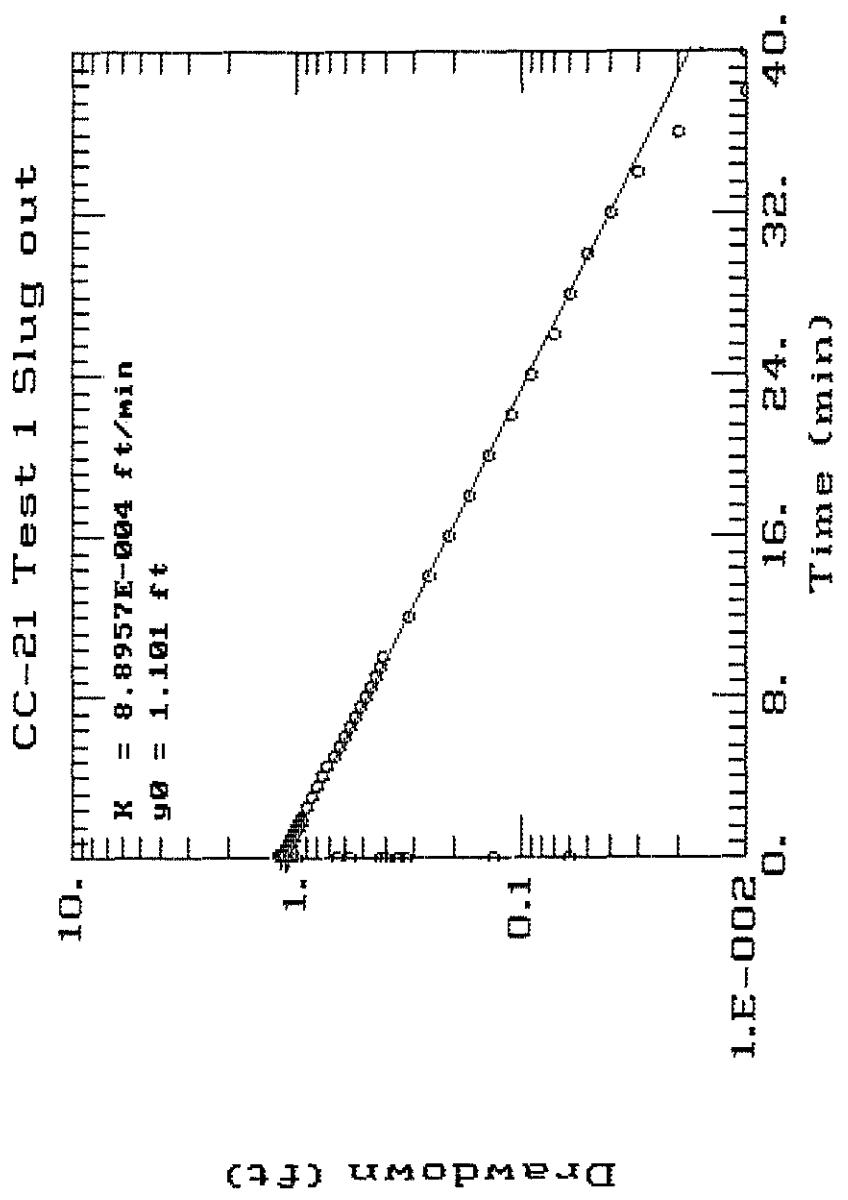
CC-20 Test 1 Slug out



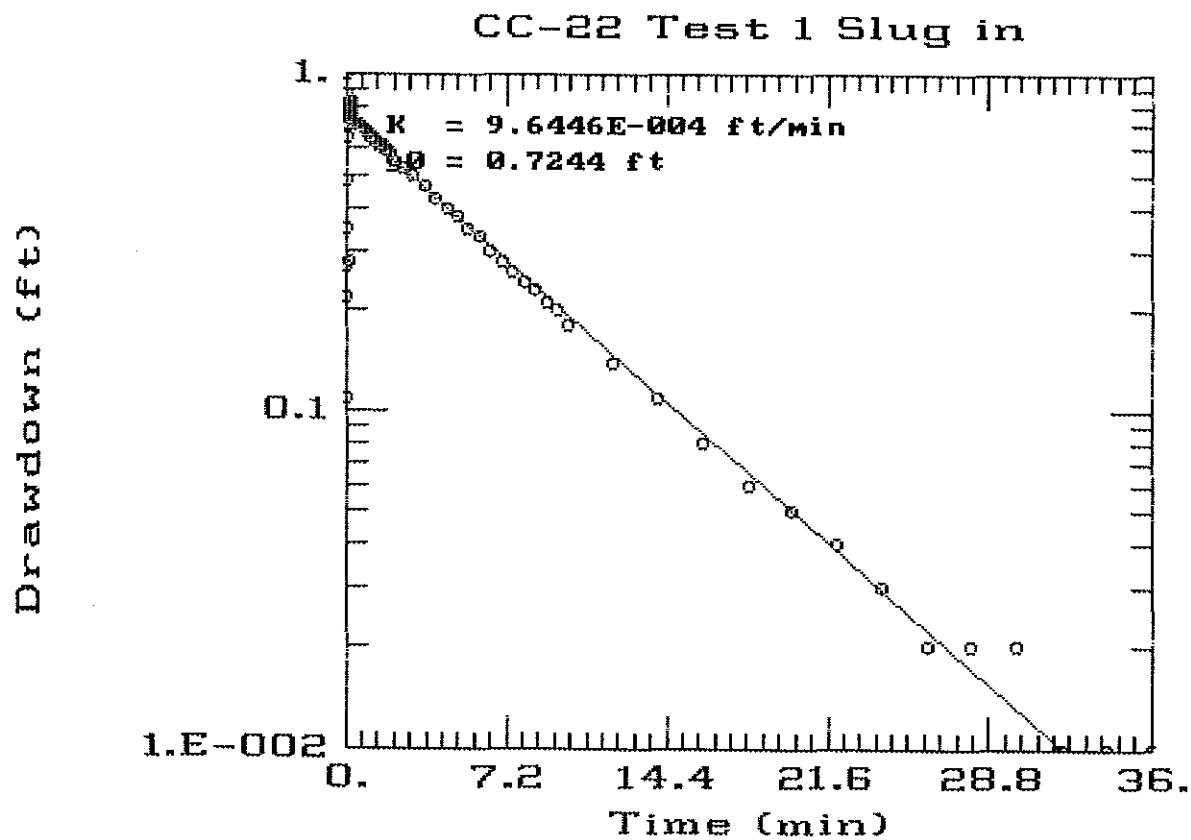
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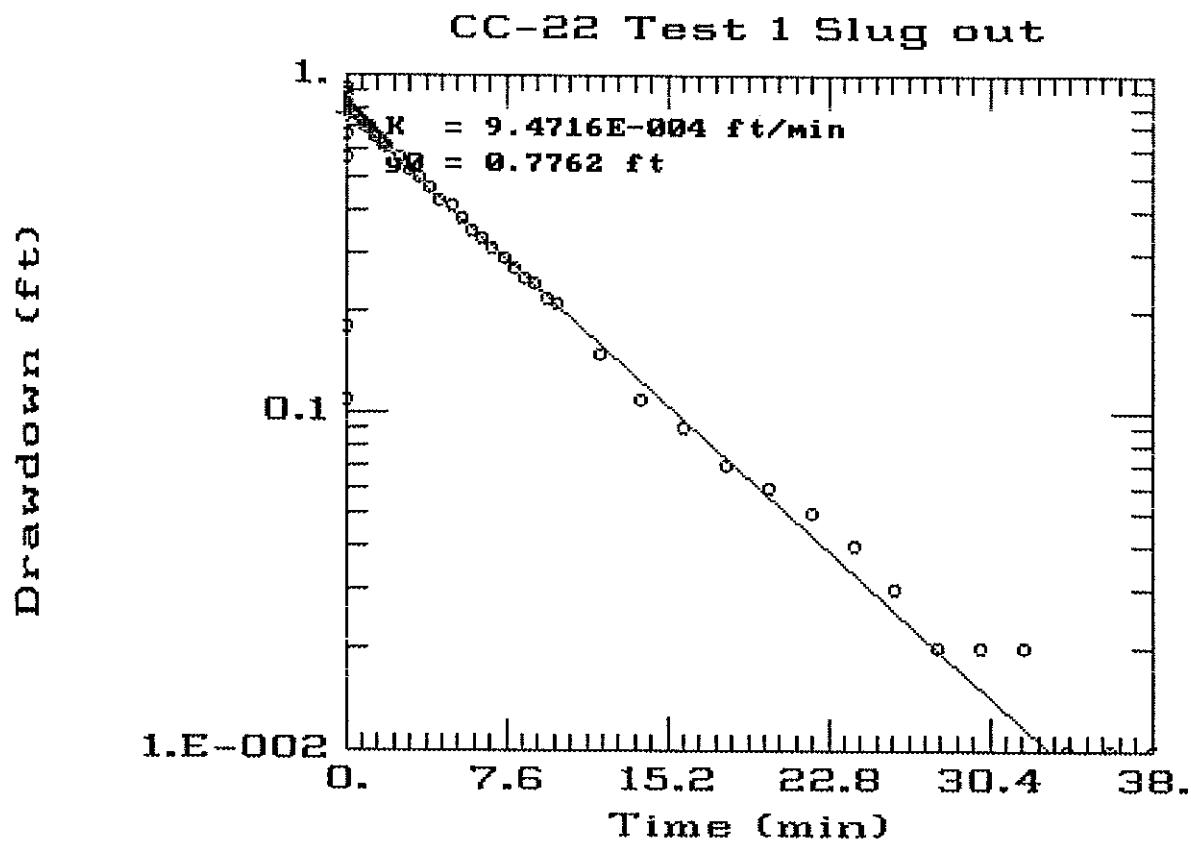
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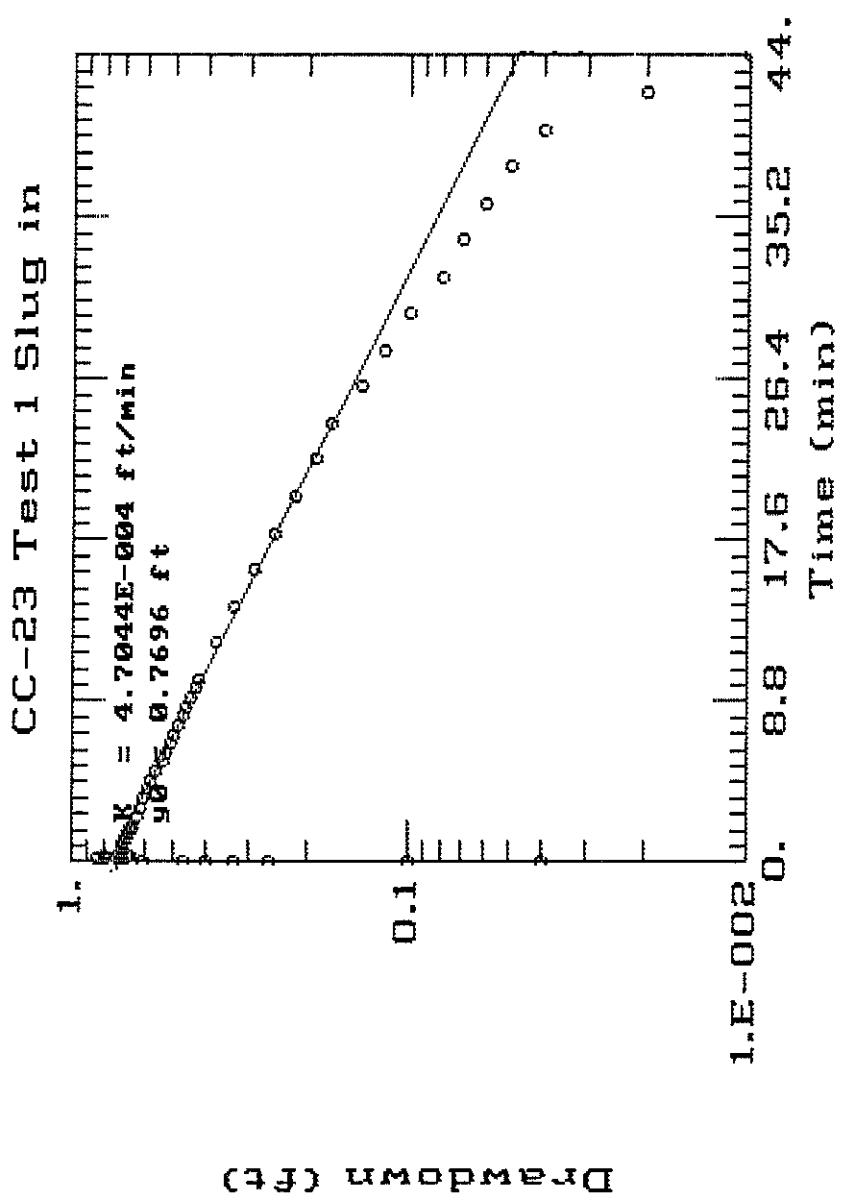
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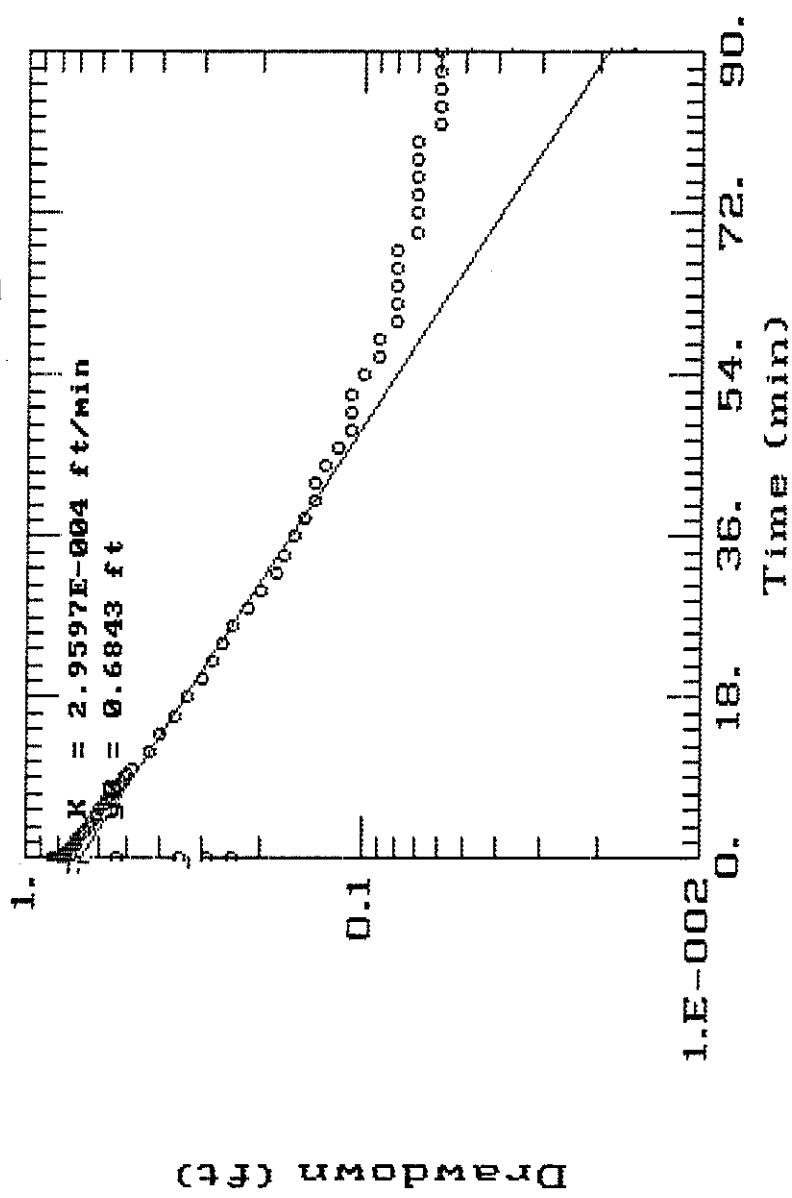


00129

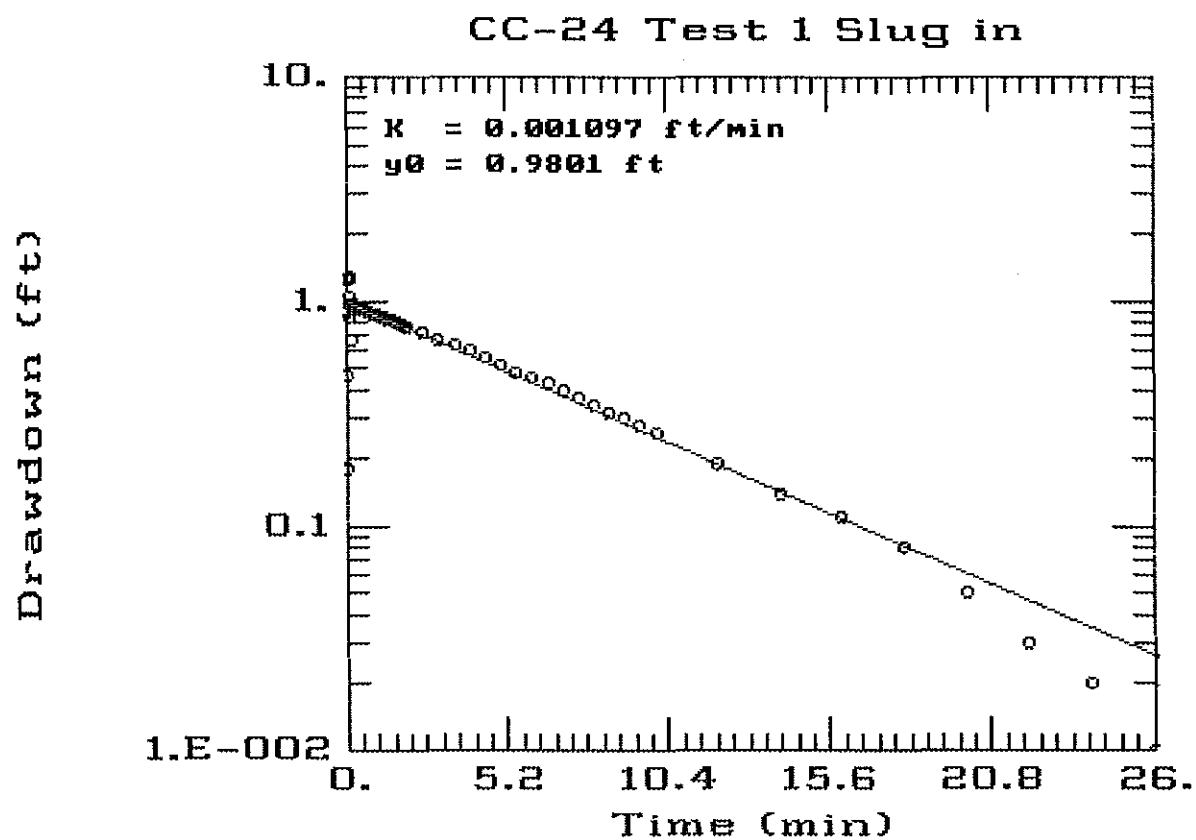


00130

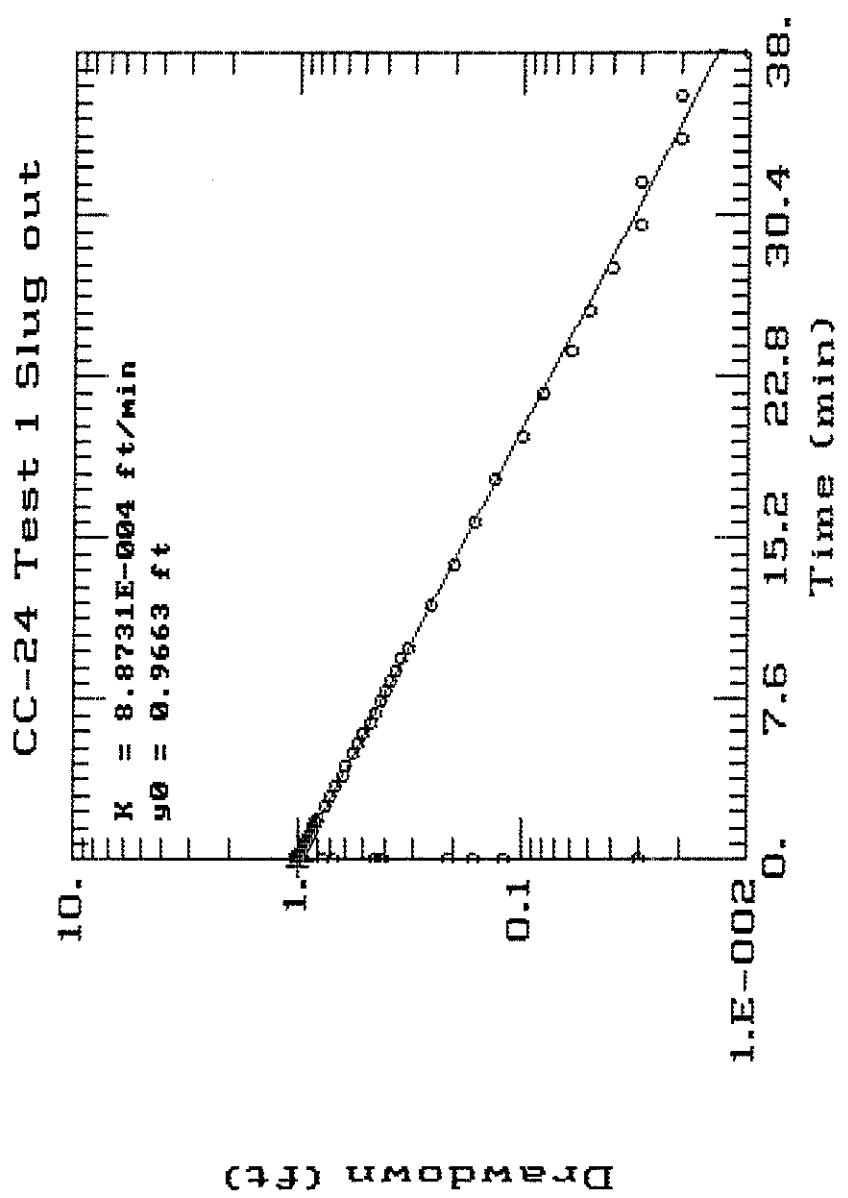
CC-23 Test 1 Slug out



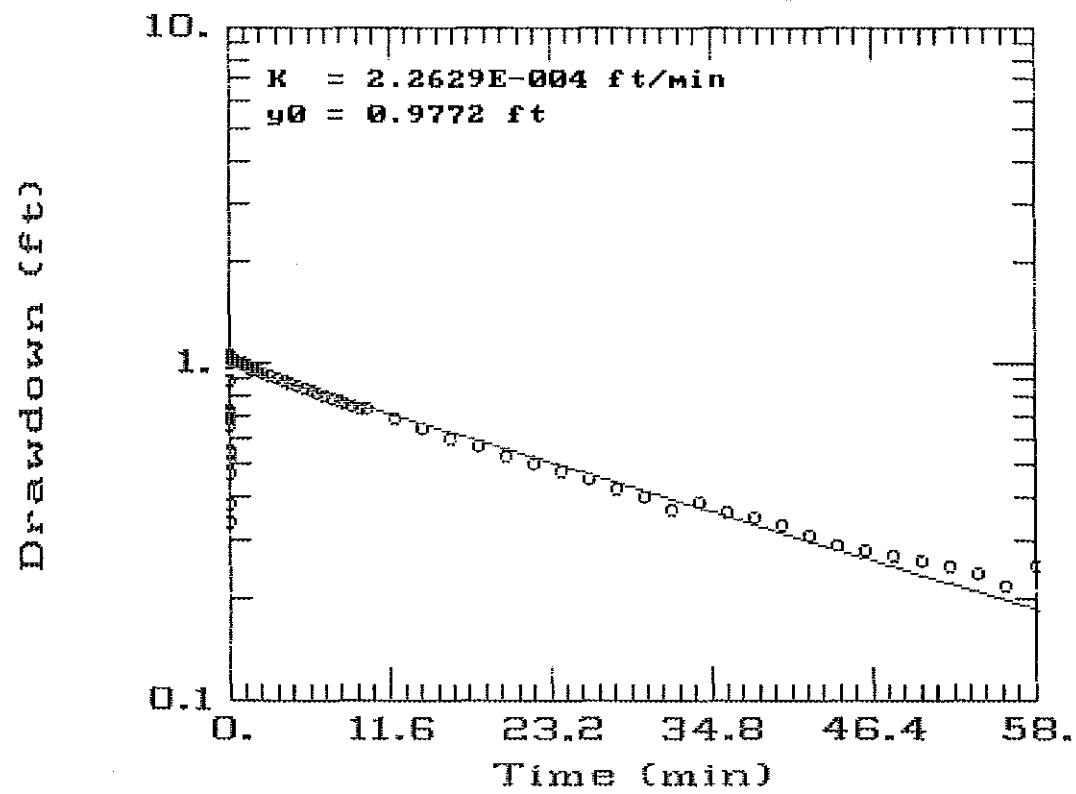
Test 00



00132

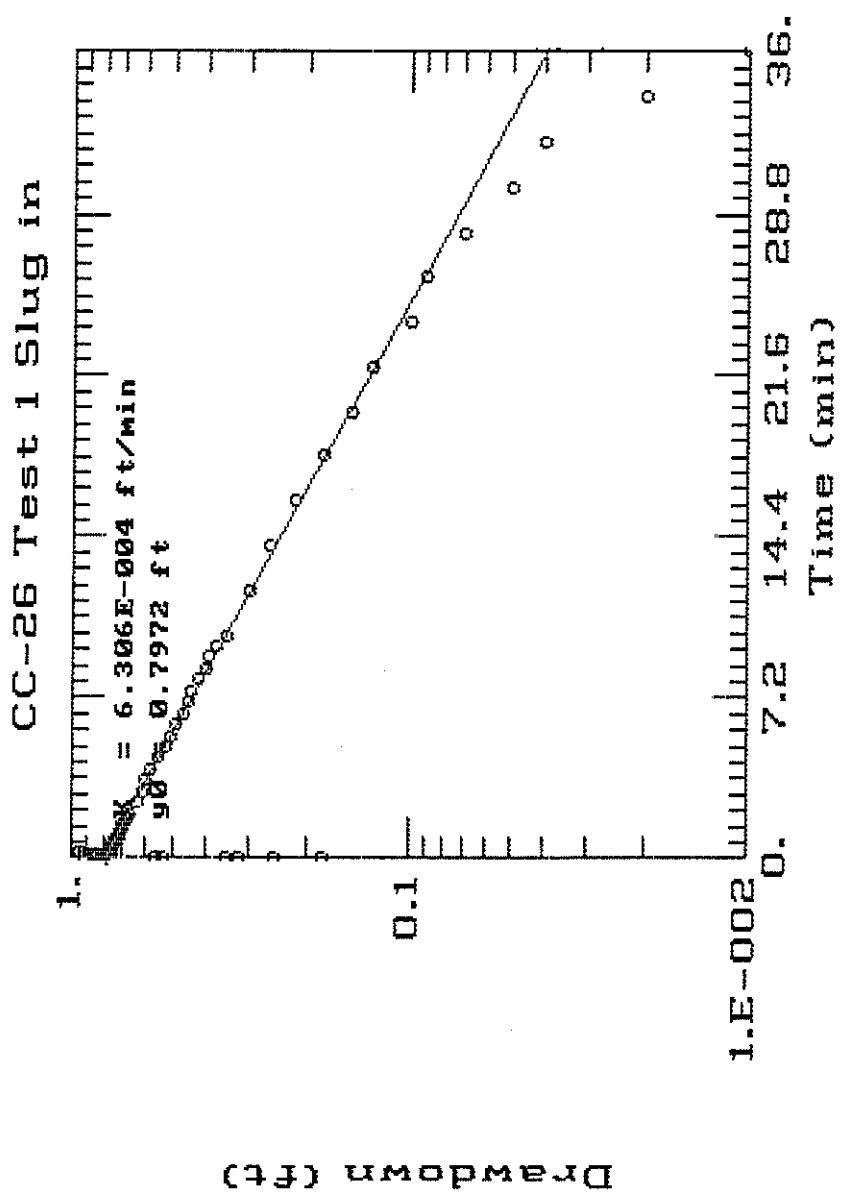


CC-25 Test 1 Slug out

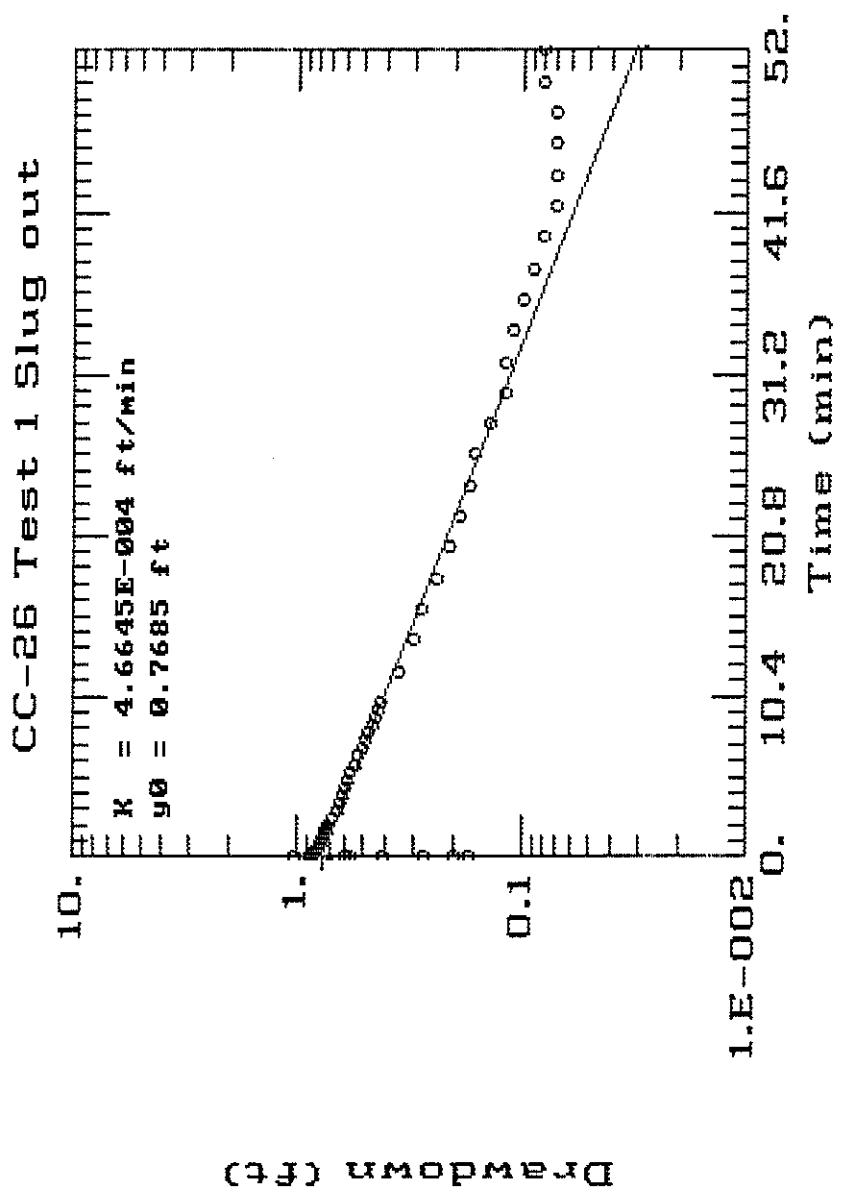


00133

00134



00135

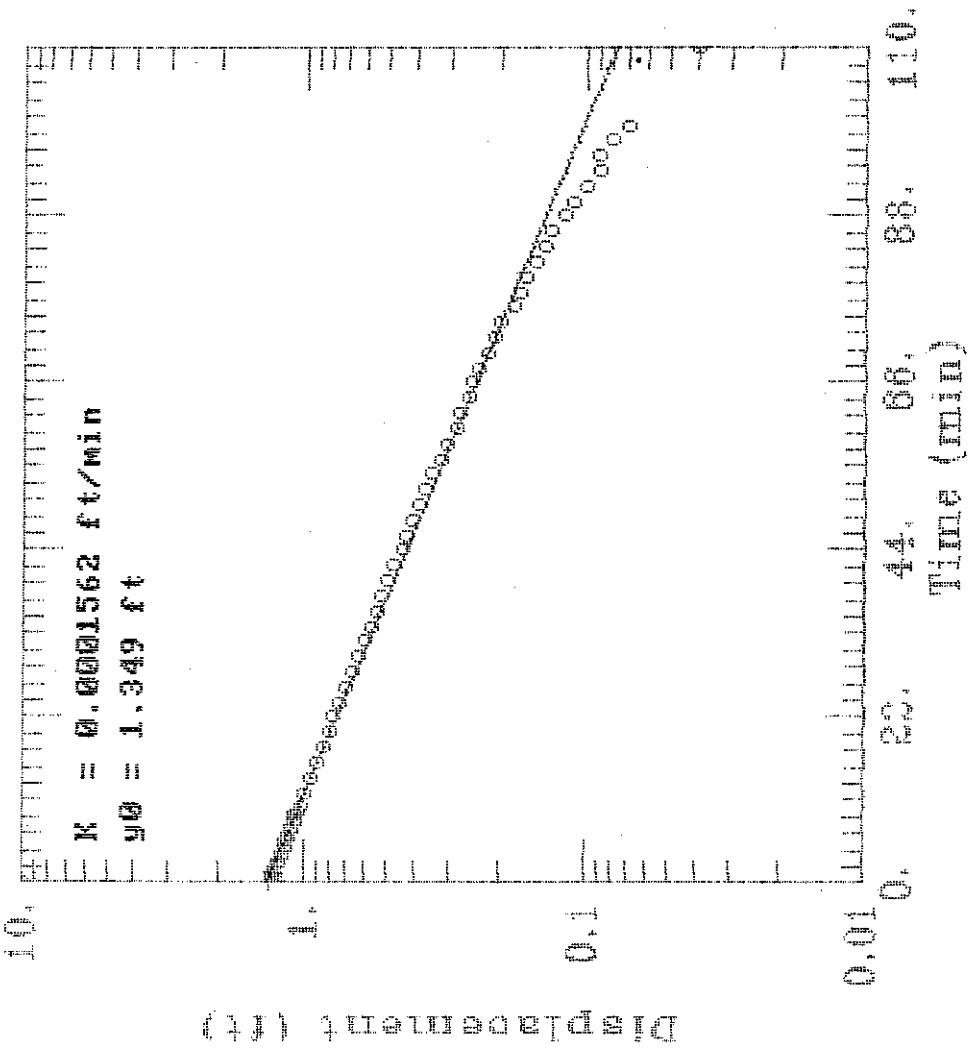


00136

Piezometer (baidown) tests - Site 1

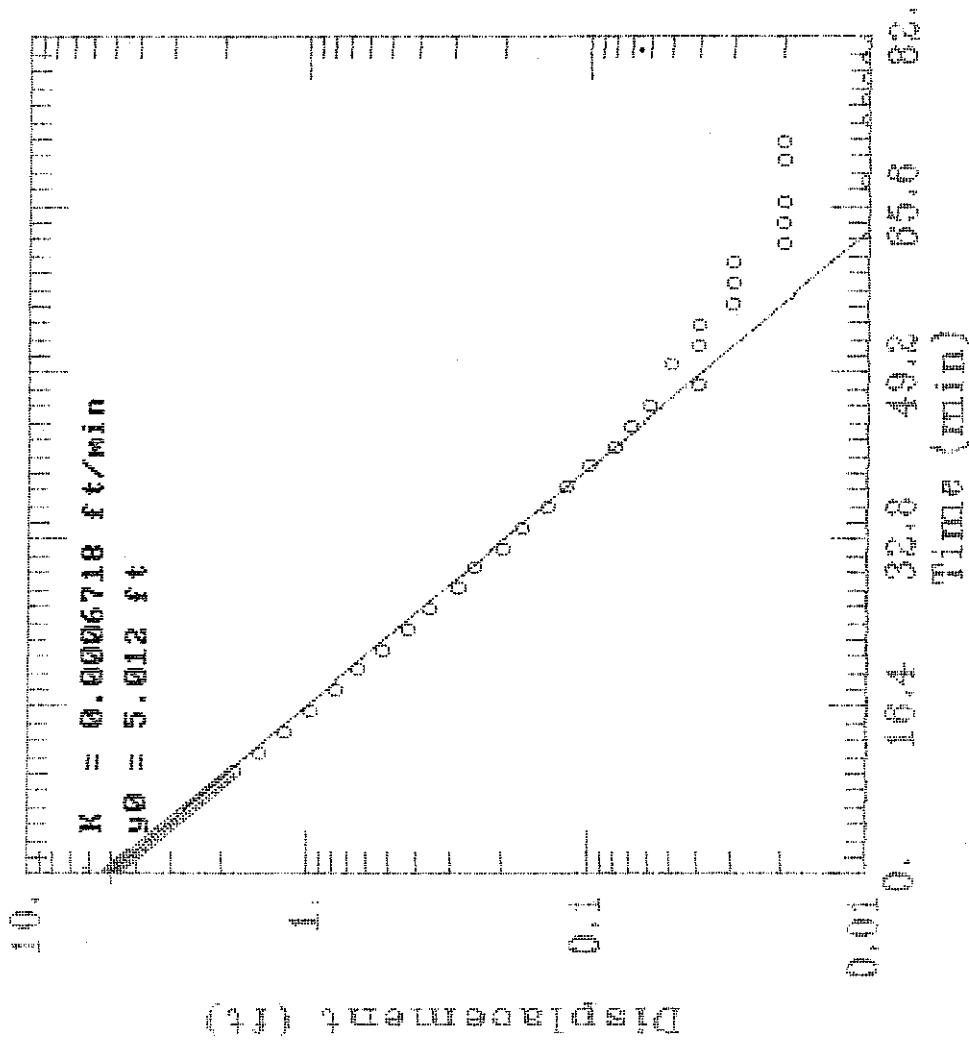
00137

R=1 Heil Test 1



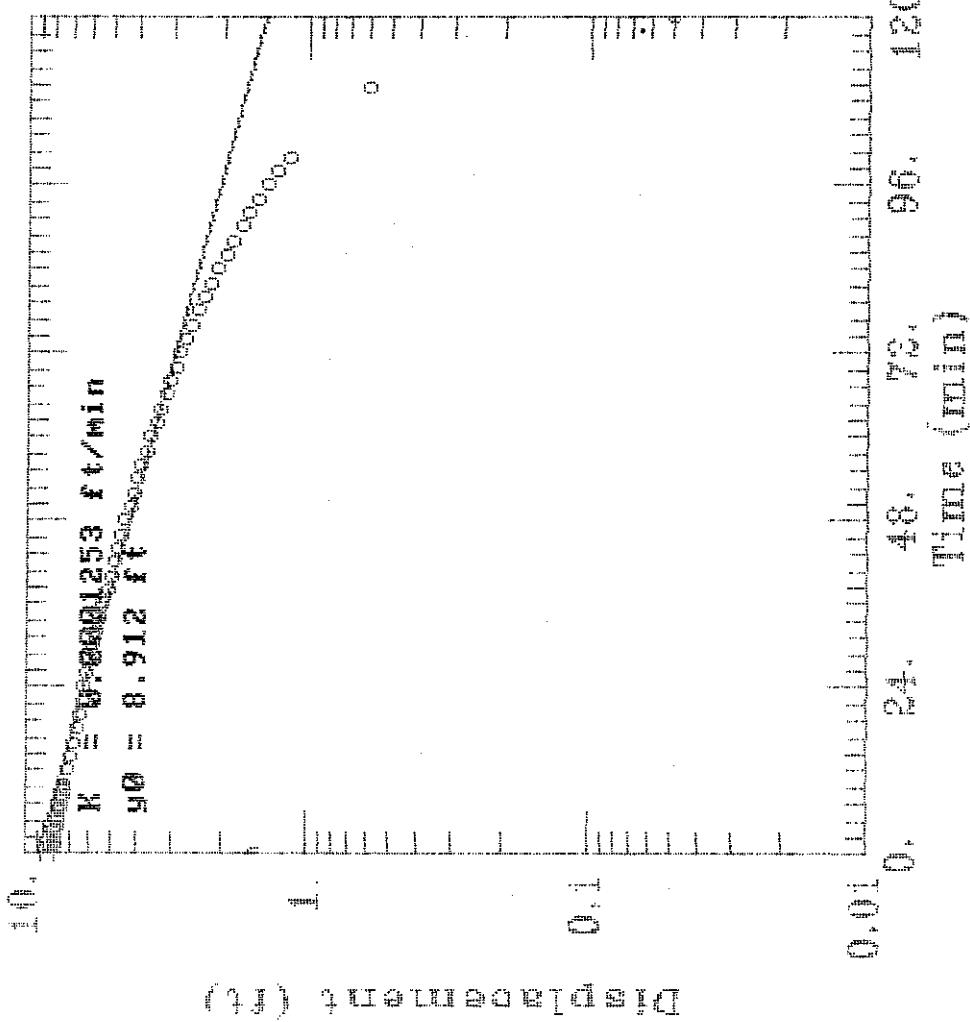
00138

R-2 Hail Test 1



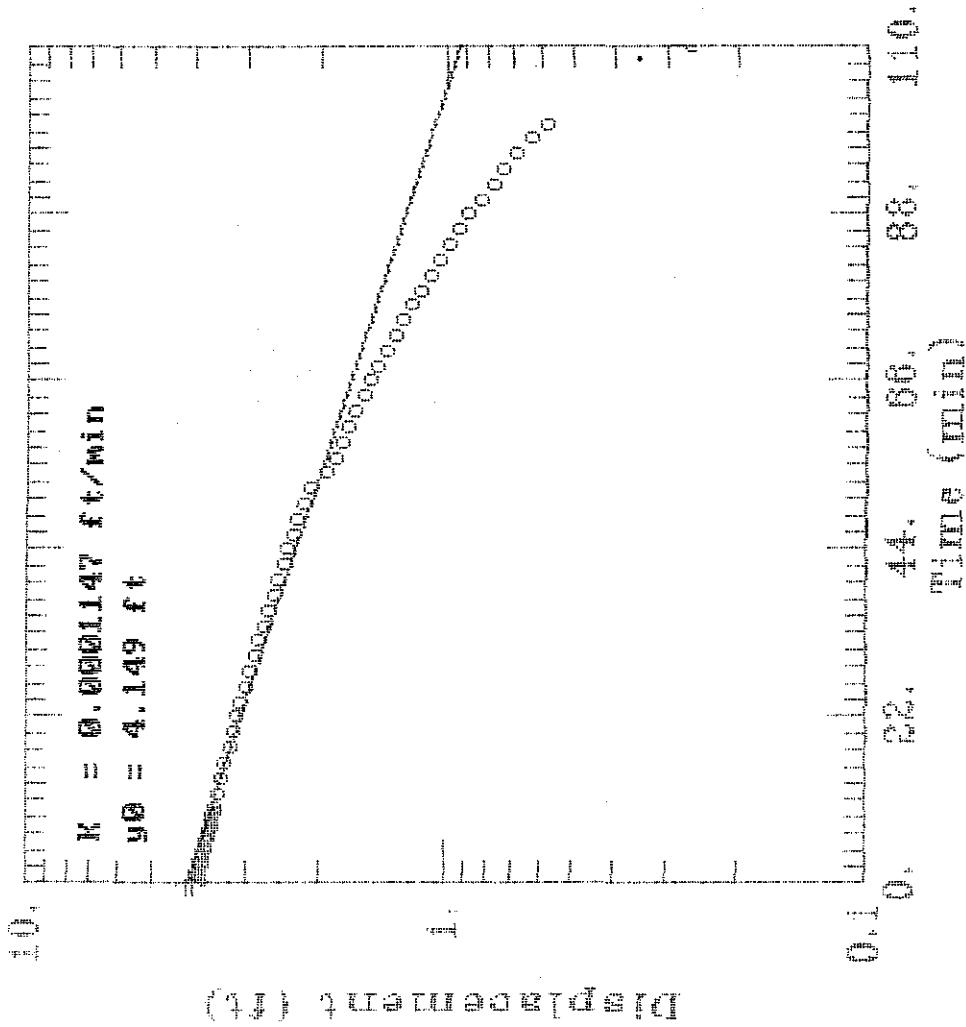
00139

R-3 Ball Test 1



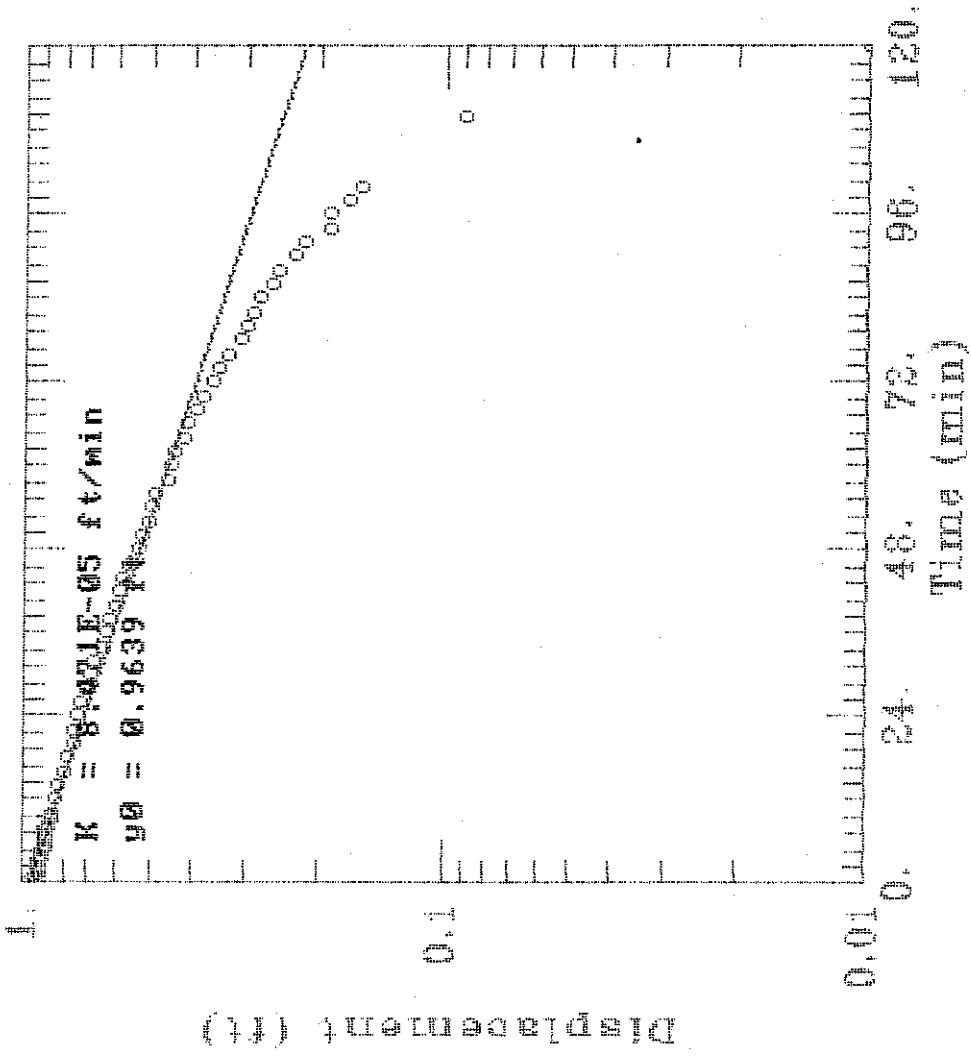
00140

R-3 Hail Test 2



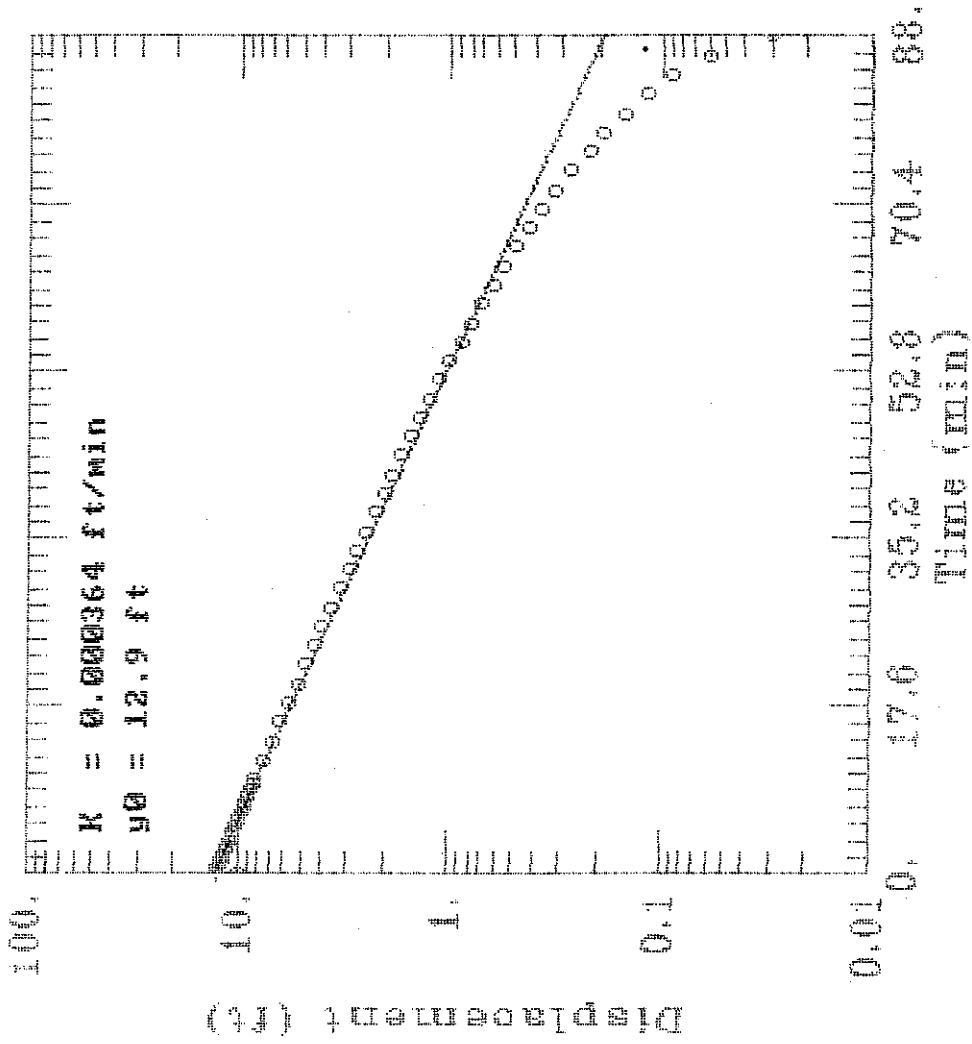
00141

R-4 Heil Test 1



00142

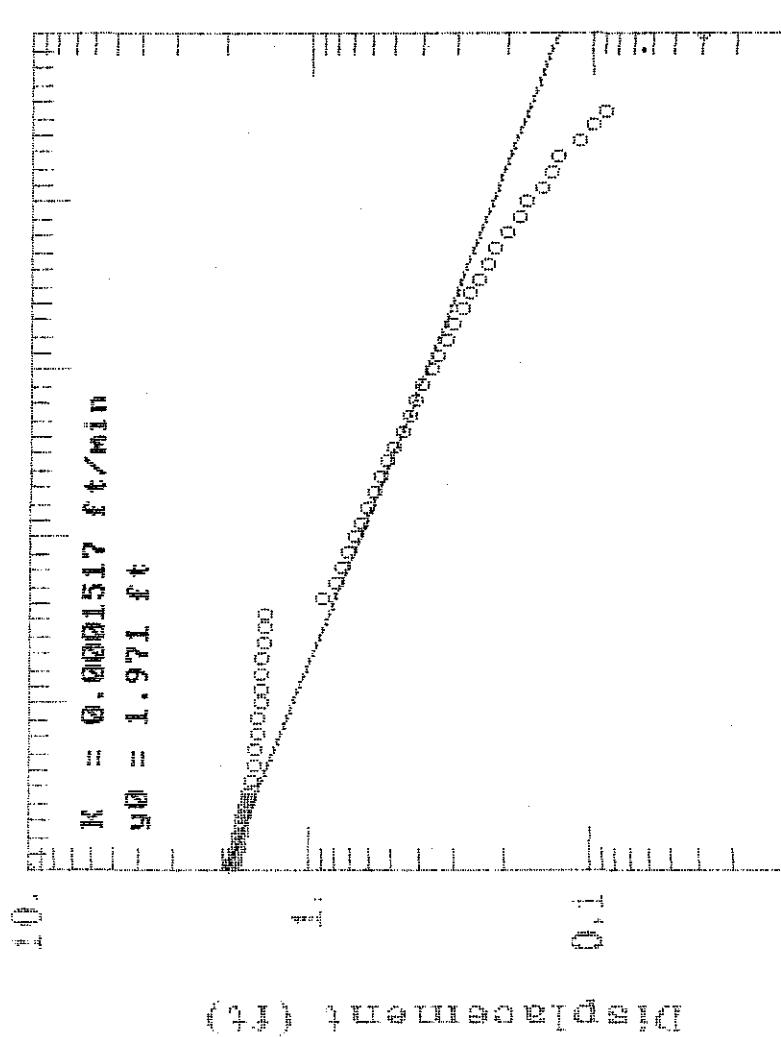
R=5 Hail Test 1



00143

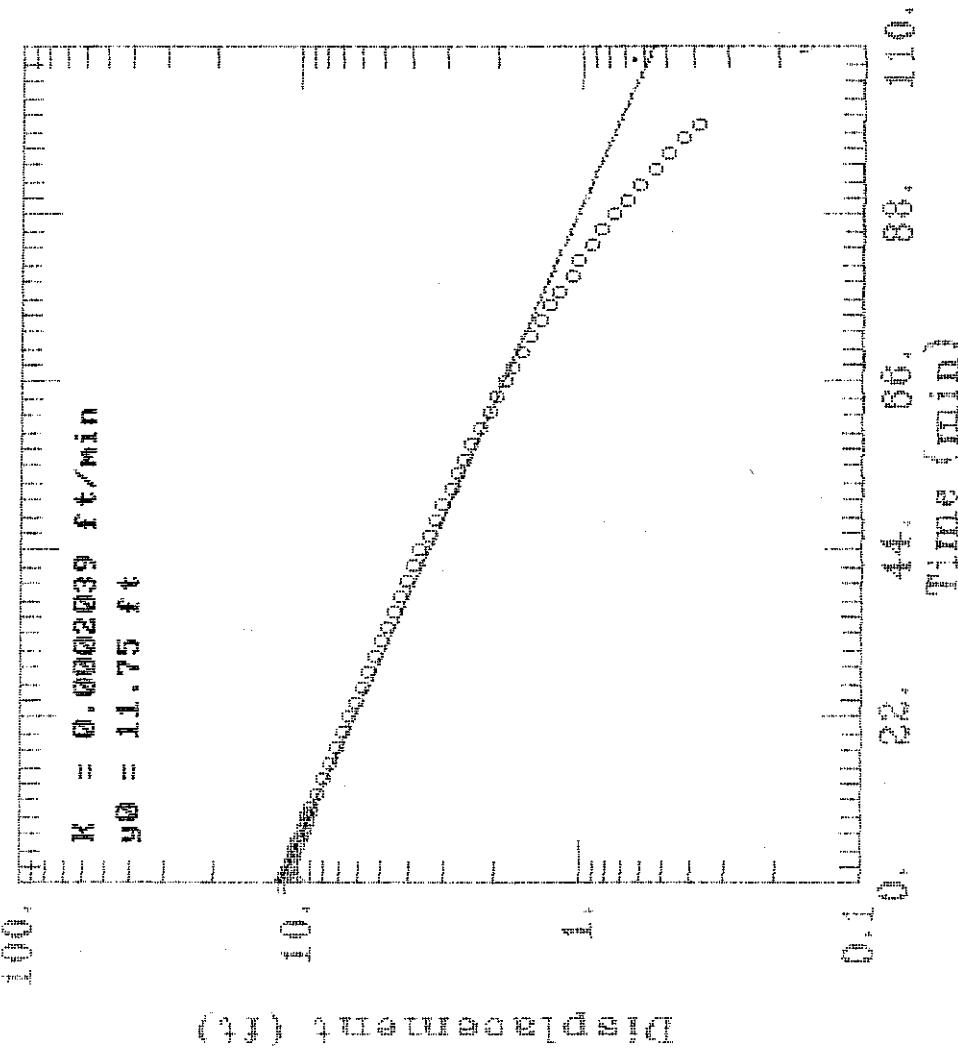
R-6 bell test 1

$$M_{\mathrm{D}} = 0.00001517 \text{ fm}^3/\text{MeV}$$



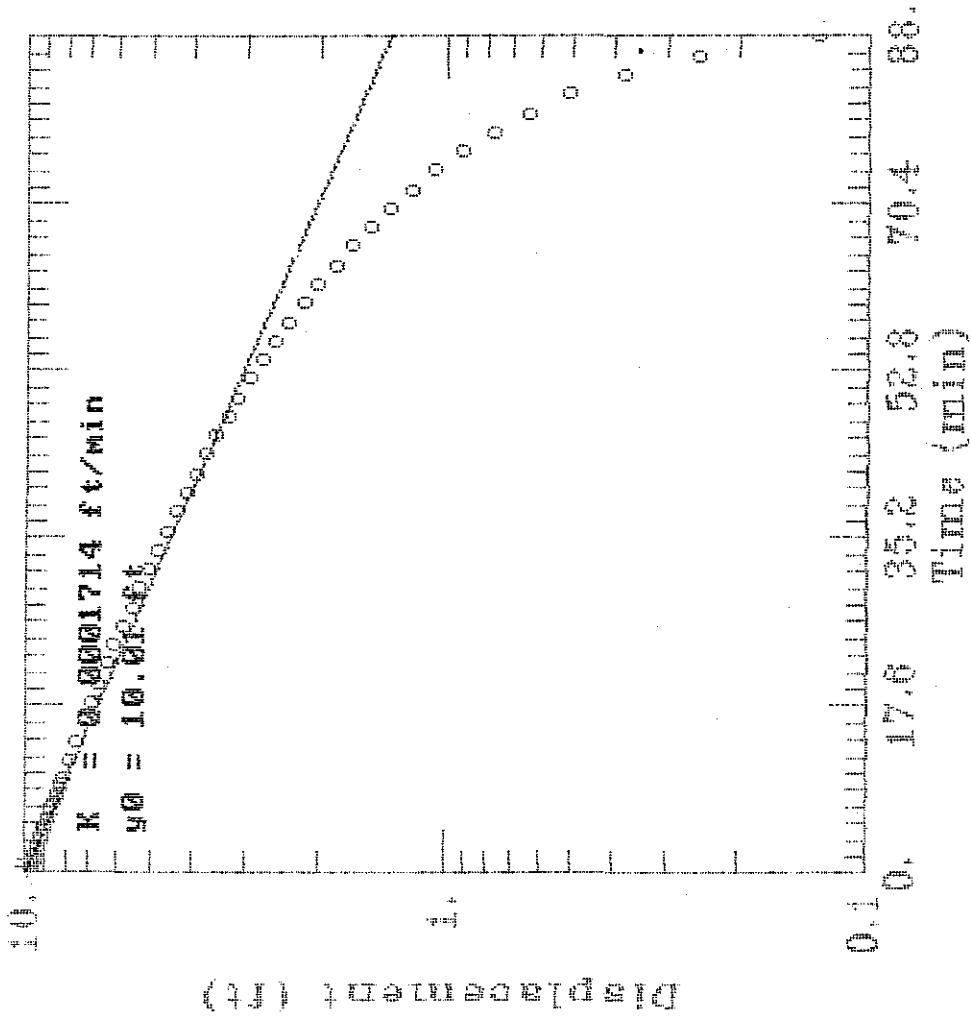
00144

R-7 ball test 1

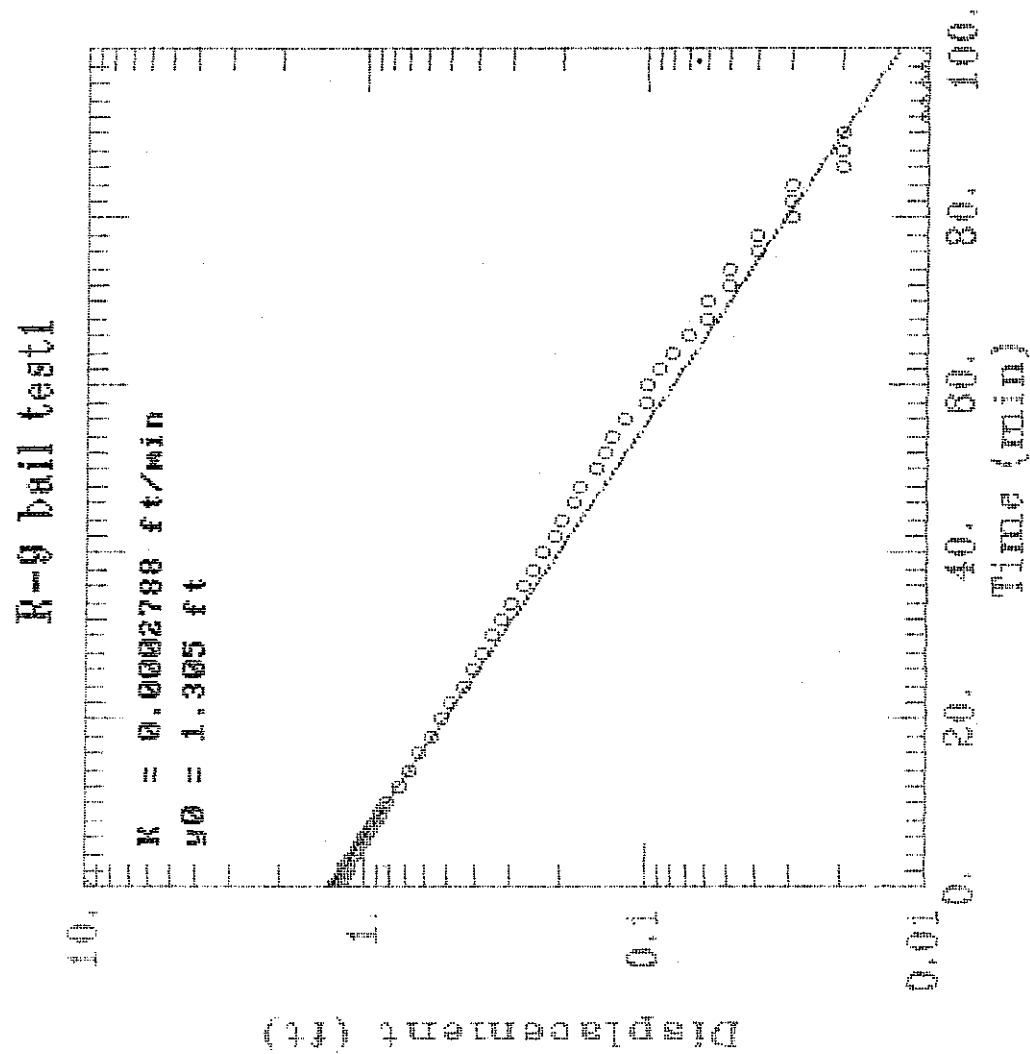


00145

R-8 ball test 1

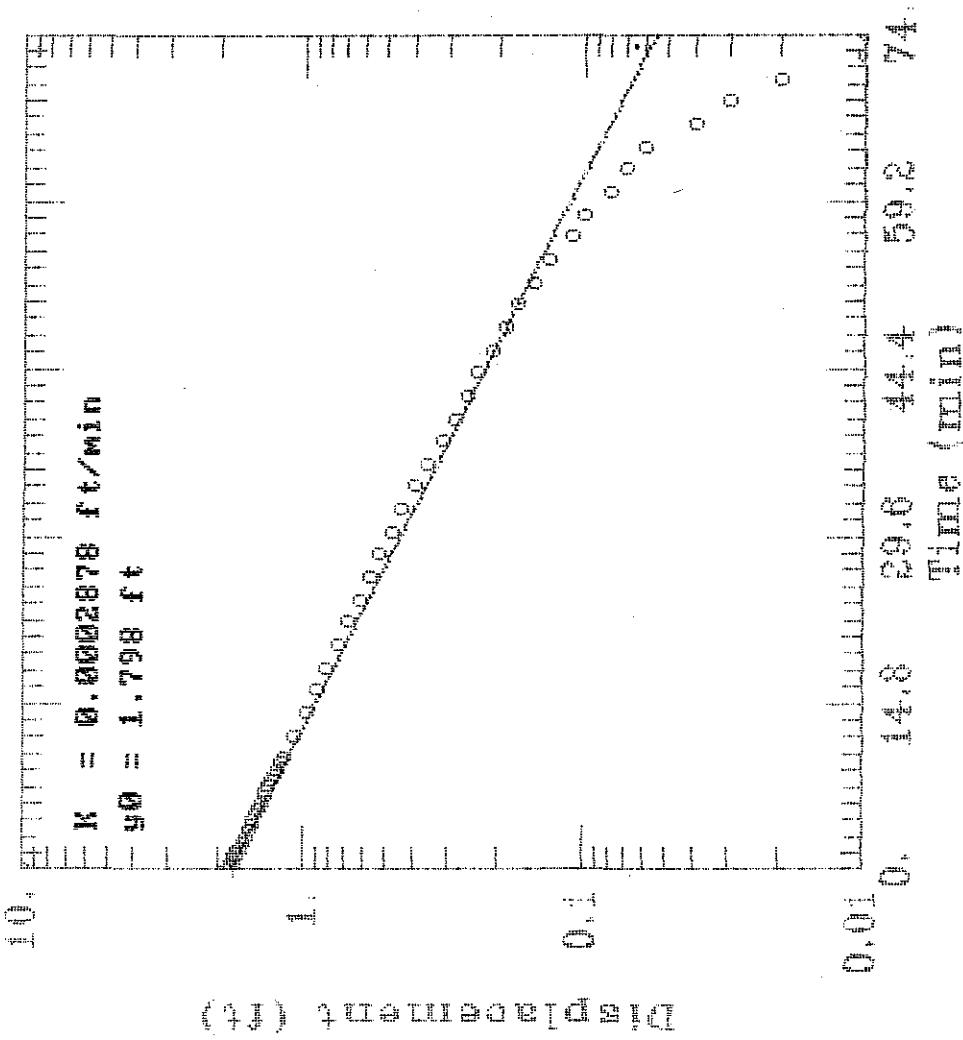


00146



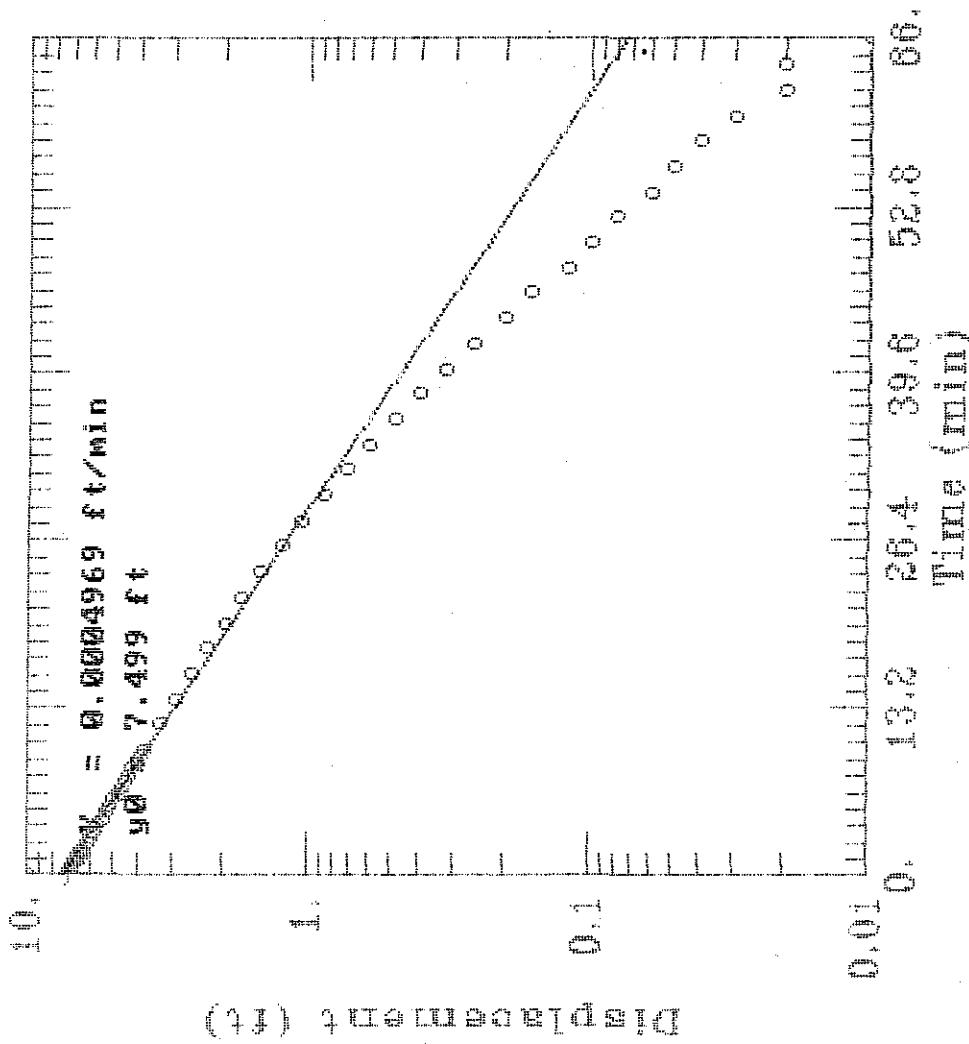
00147

R=10 ball test



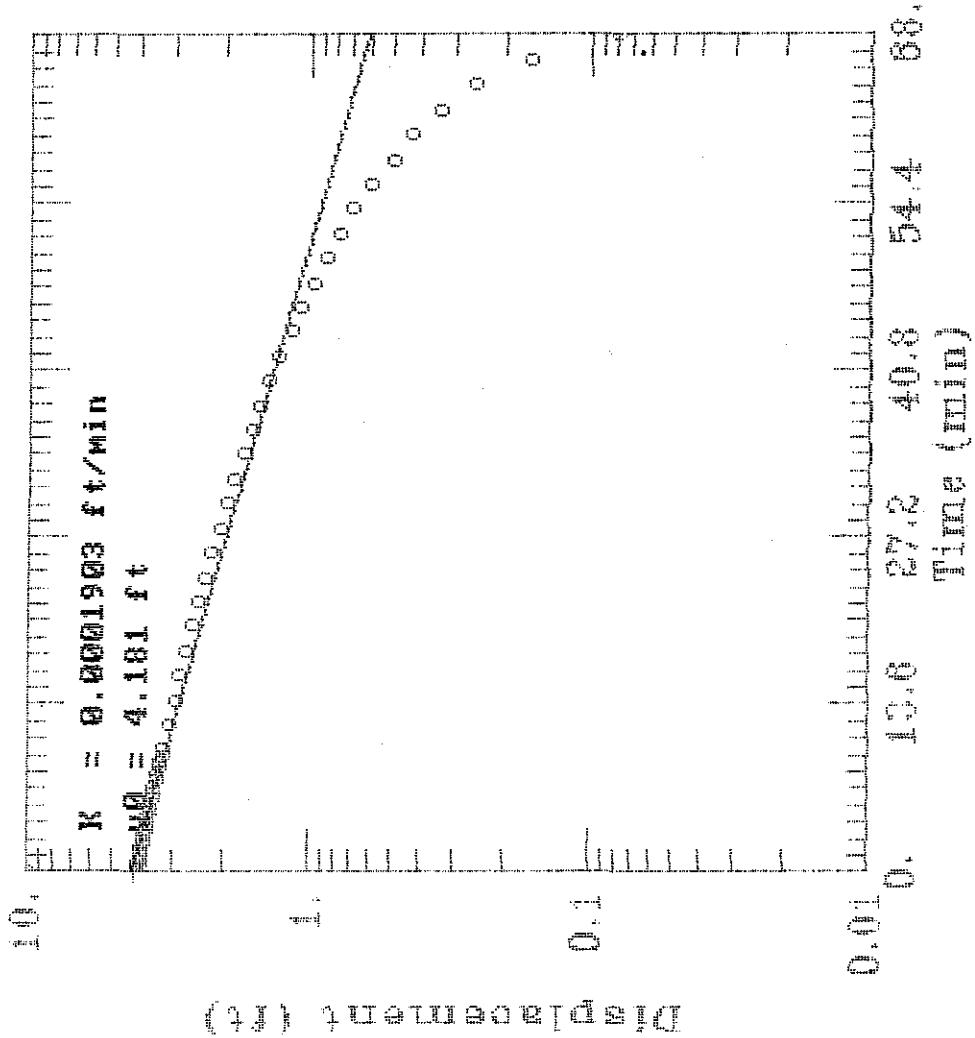
00148

H-1 bell test



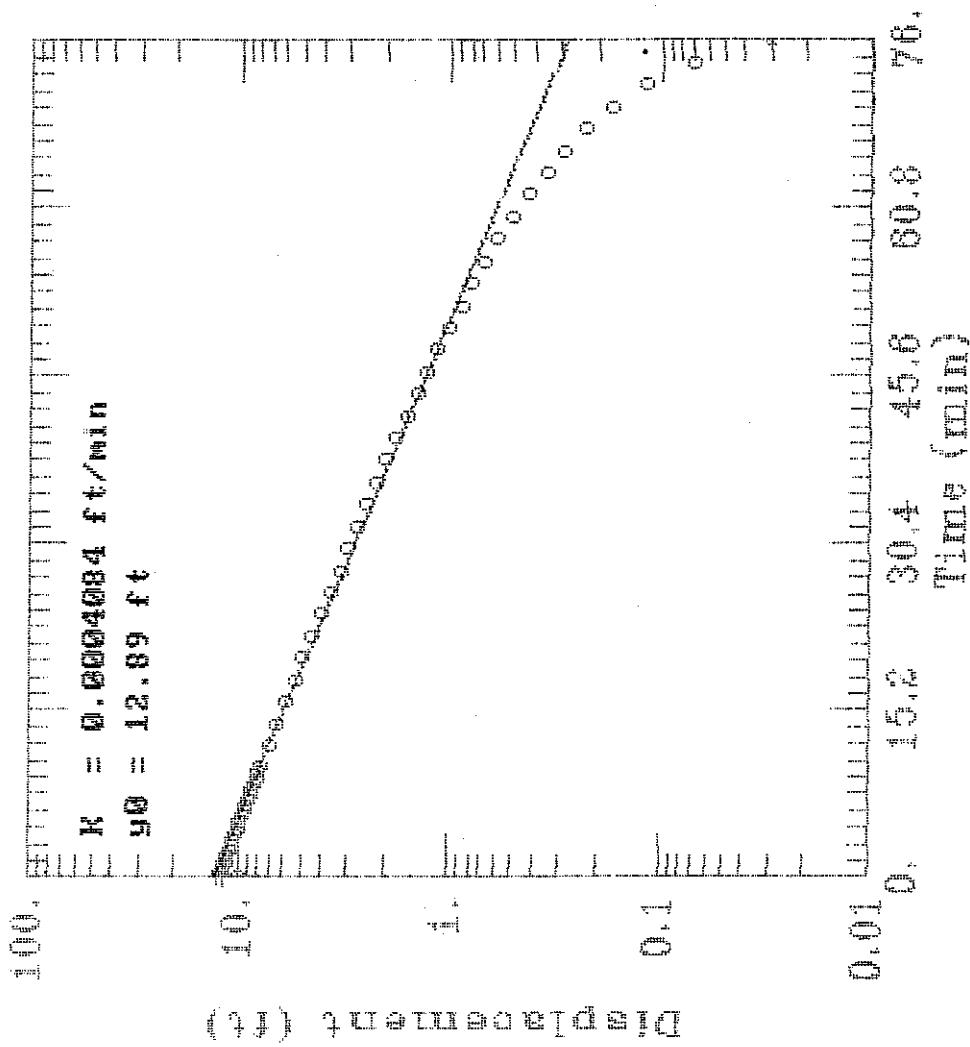
00149

R-12 ball test



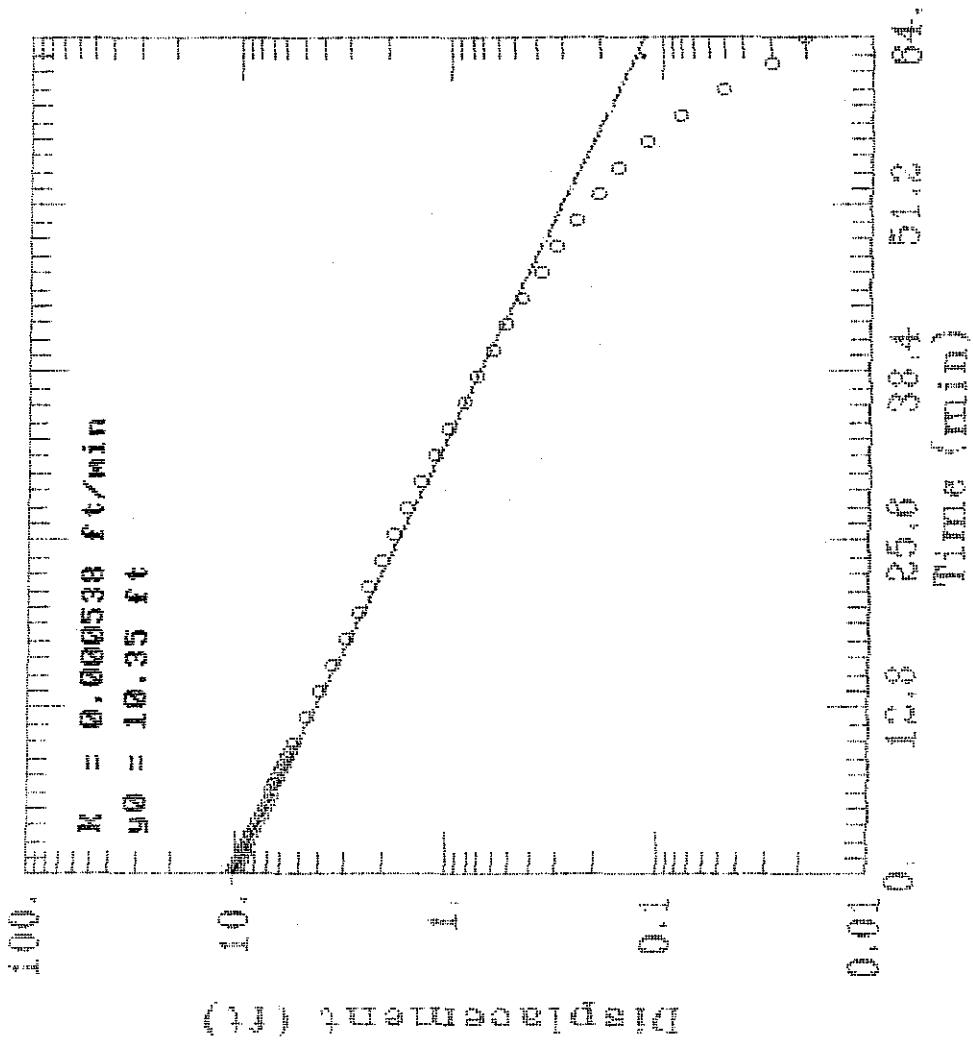
00150

R-13 ball test



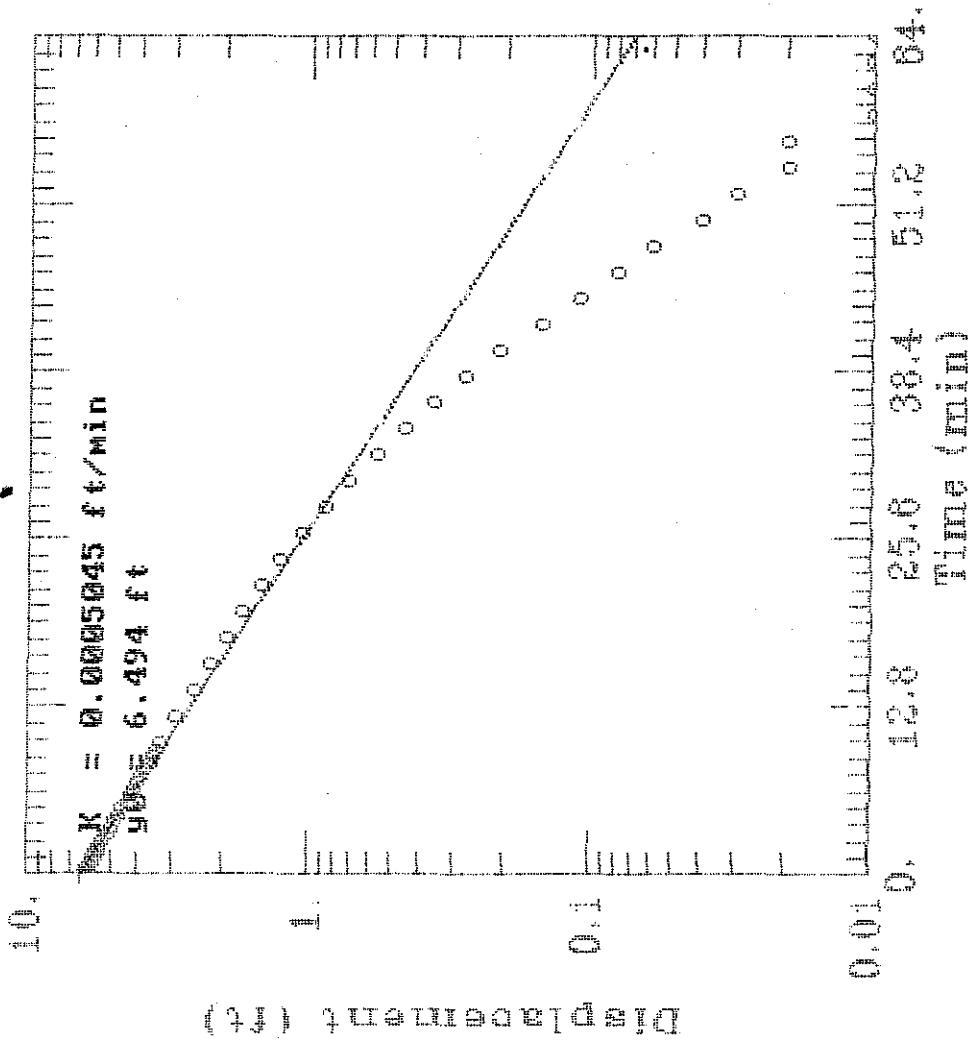
00151

R-15 Ball Test 1

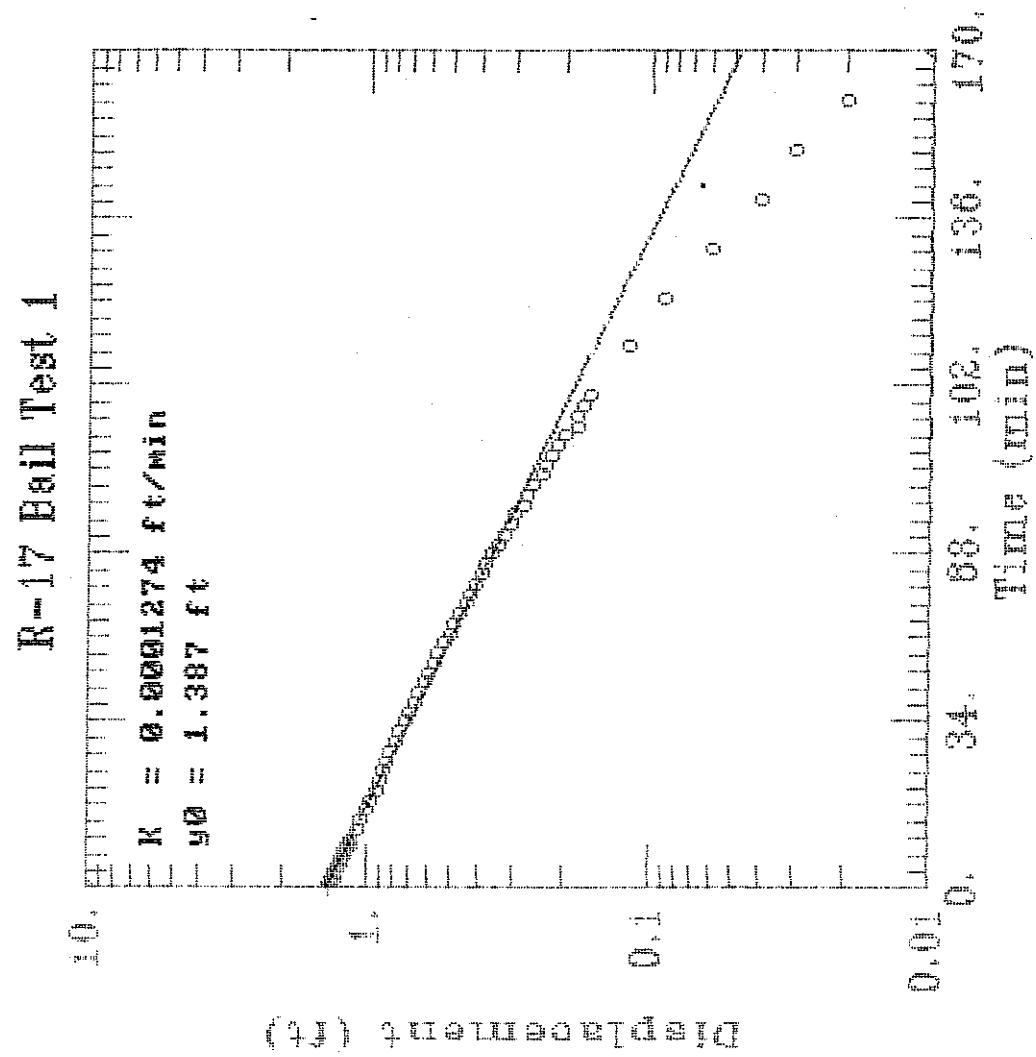


00152

R-16 Bell Test 1

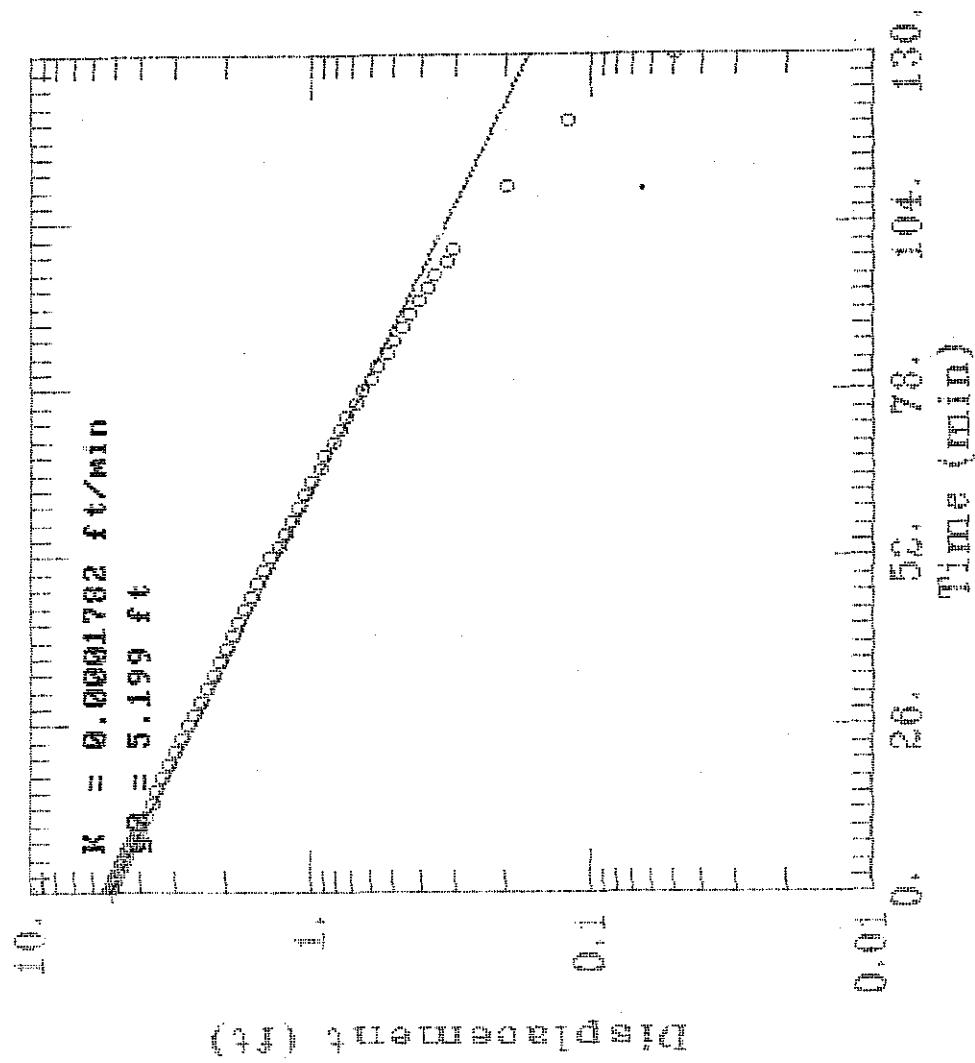


00153



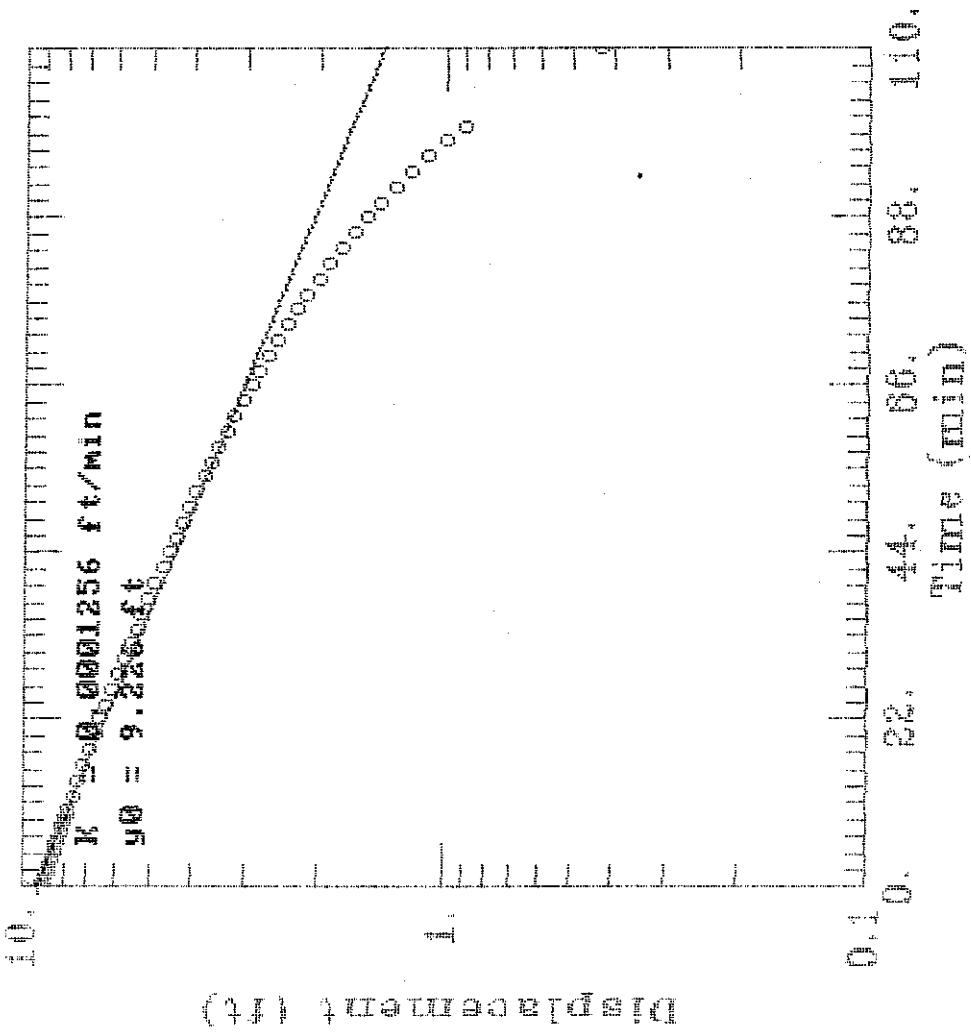
00154

R-10 Boil Test 1



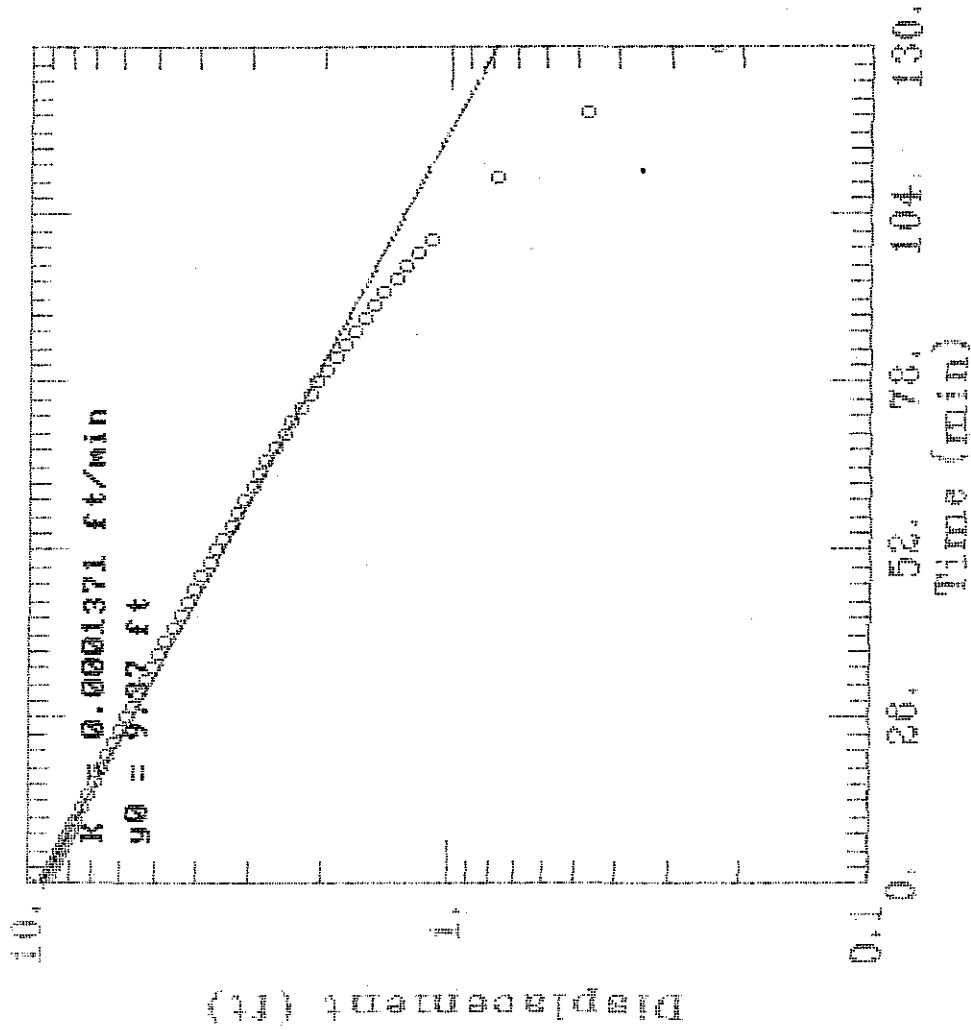
00155

R-19 Ball Test 1



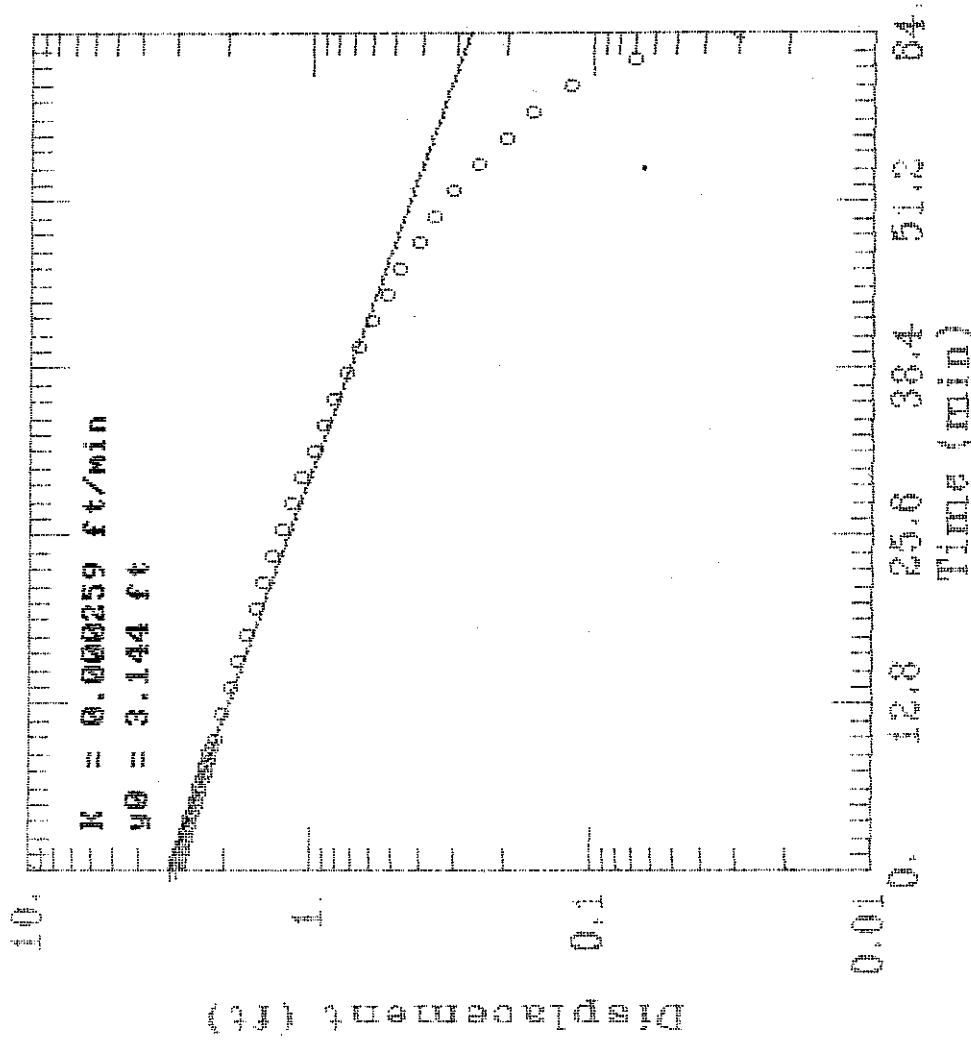
00156

R-30 Boil Test 1



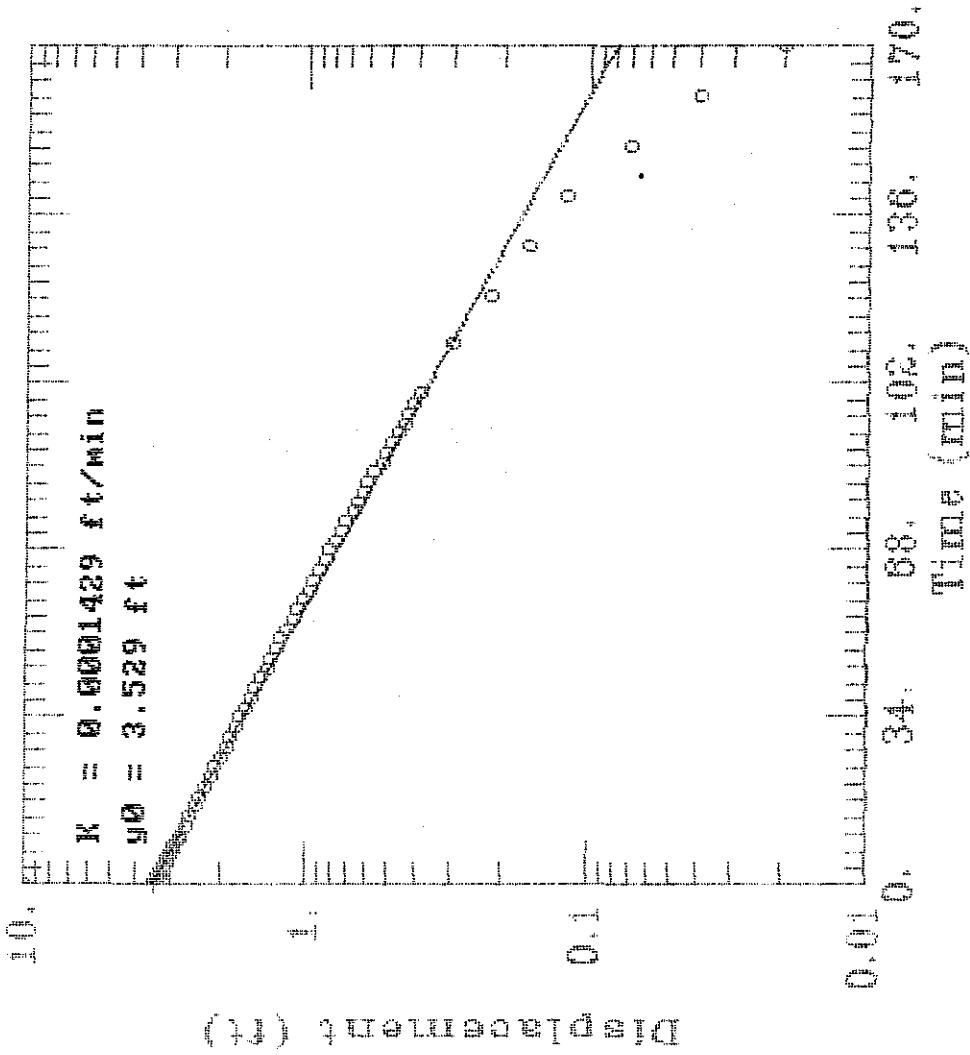
00157

R-31 Boil Test 1

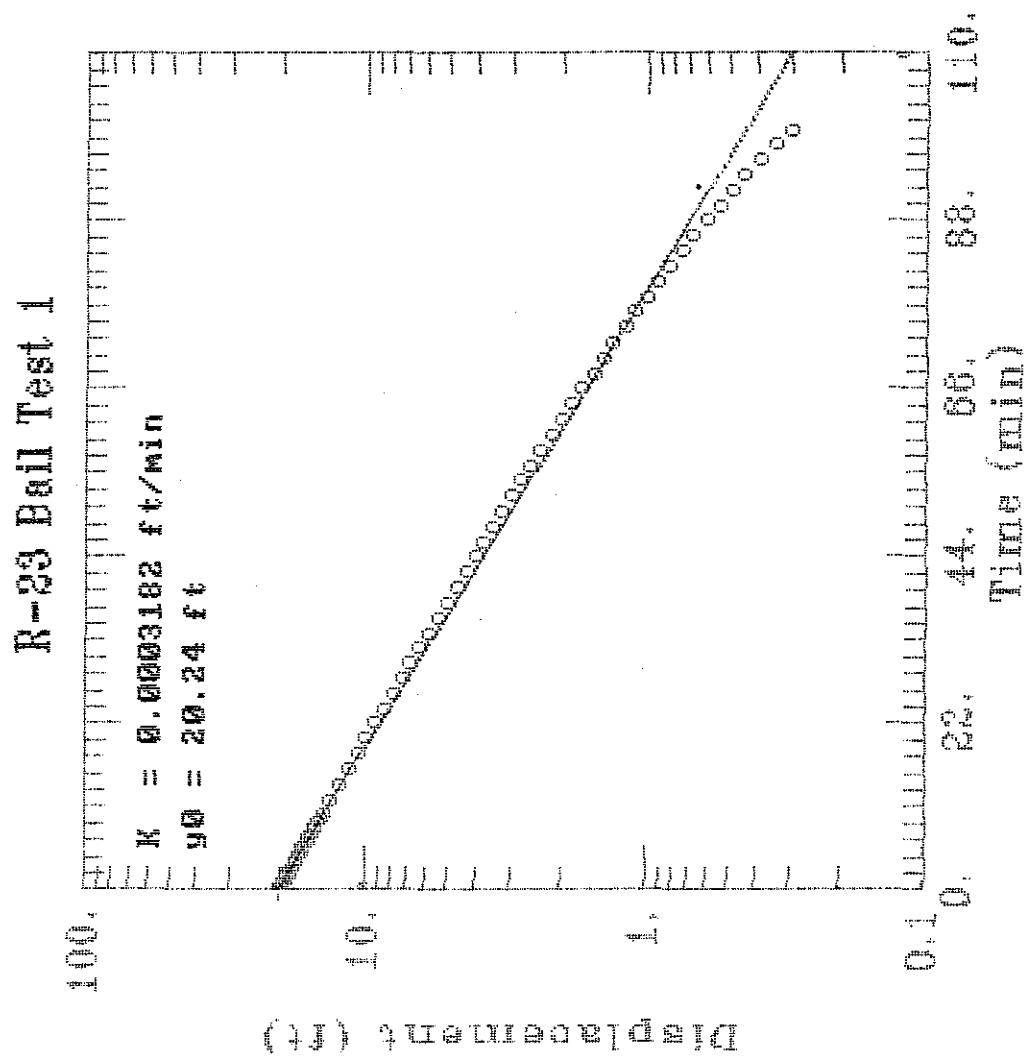


00158

R-32 Bail Test 1

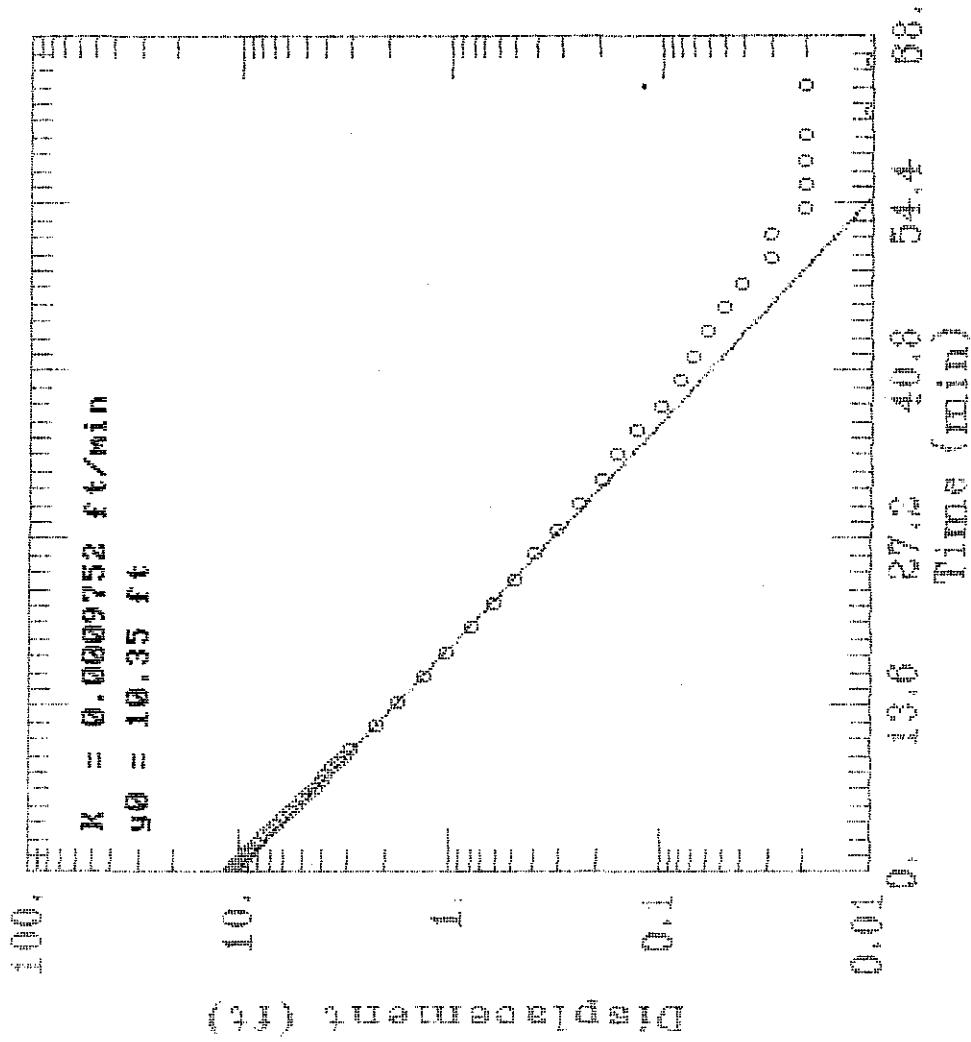


00159



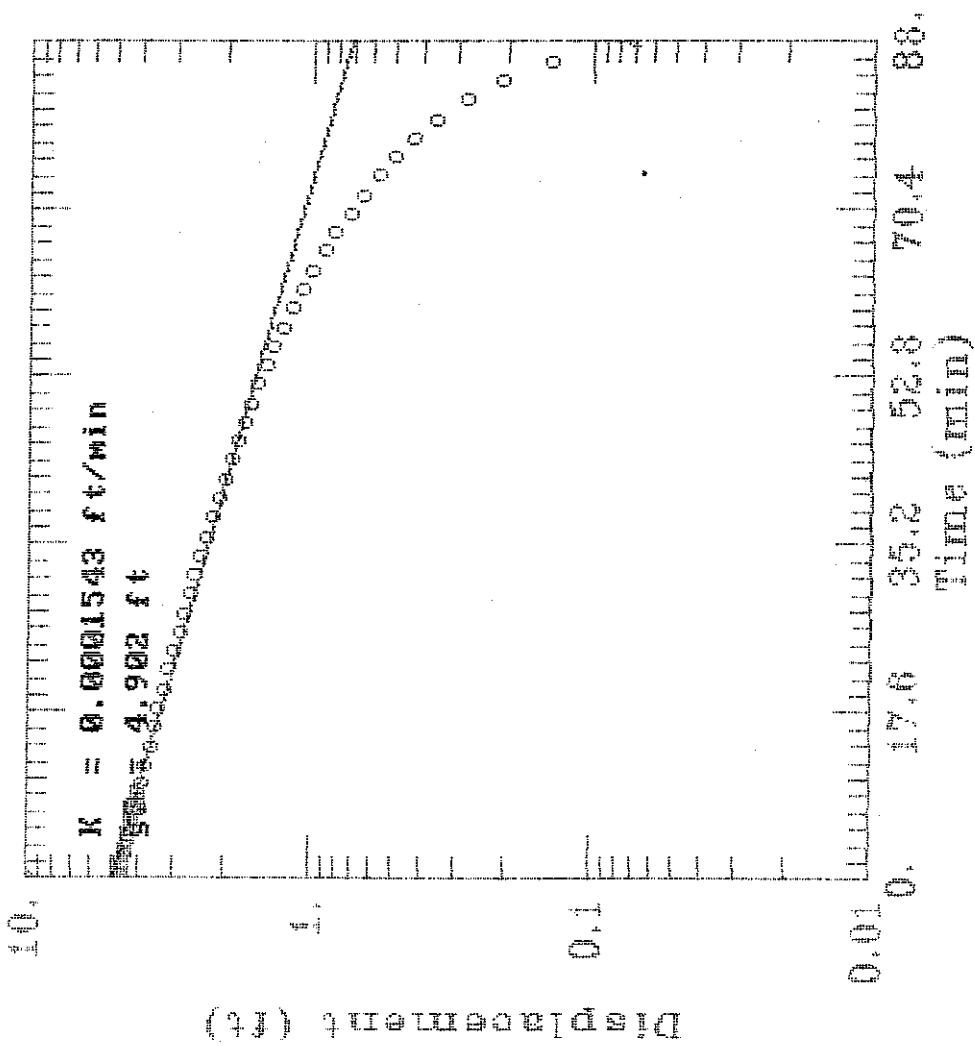
00160

R-34 B91 Test 1



00161

R-35 Ball Test 1

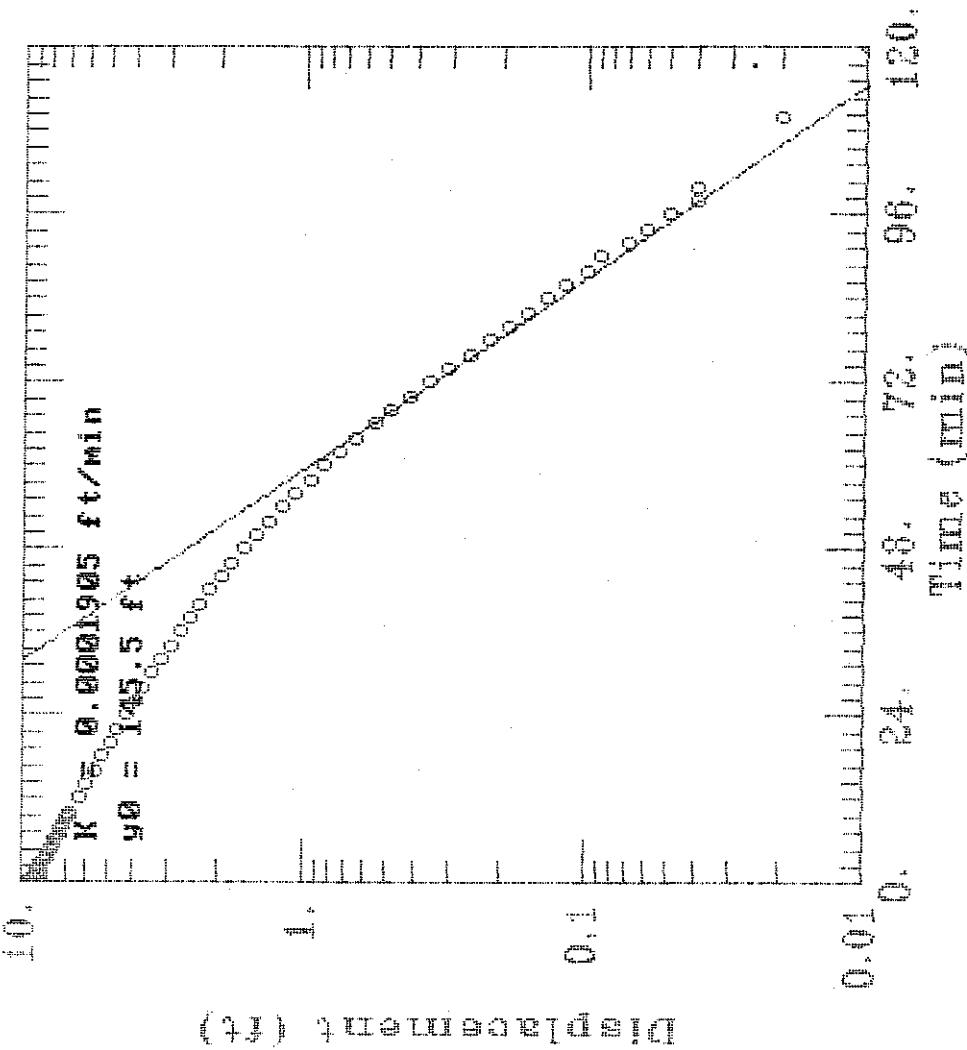


00162

Piezometer (baileys) tests - Site 2

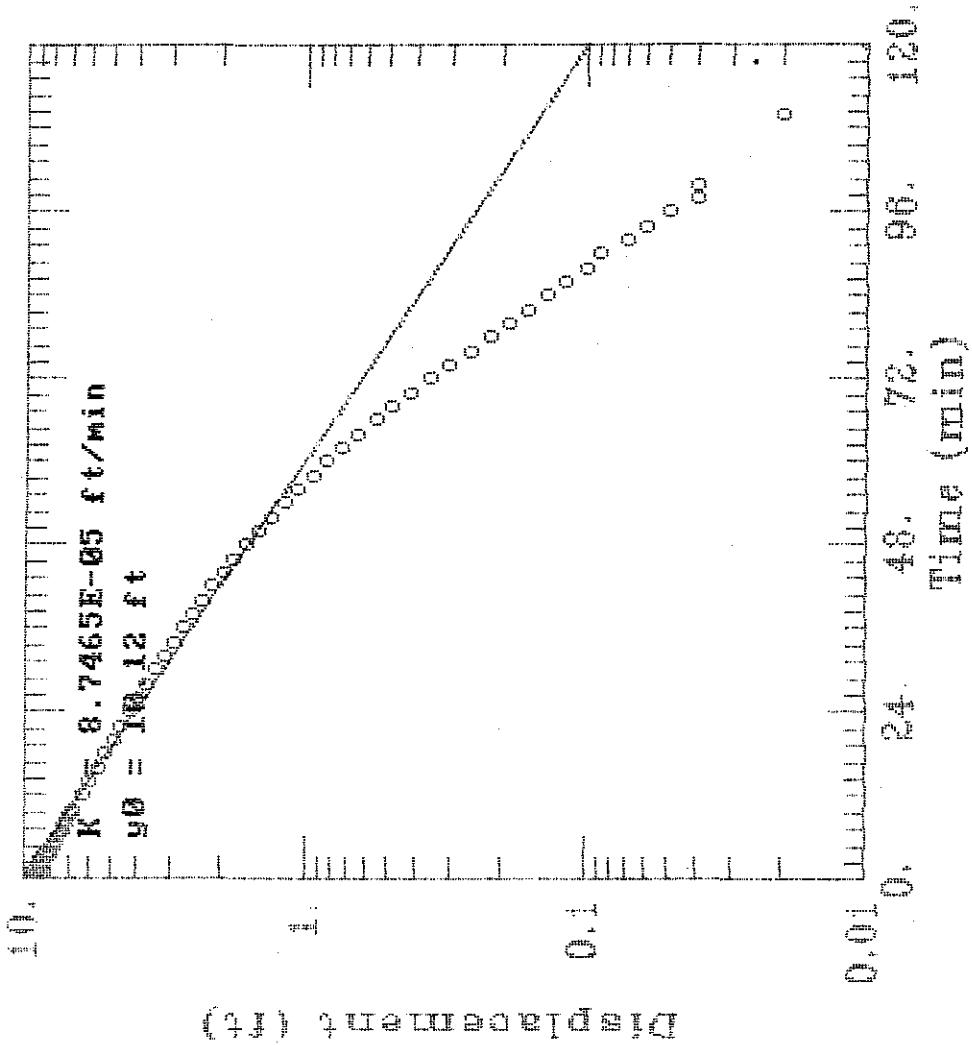
00163

CC-0 Ball Test 1



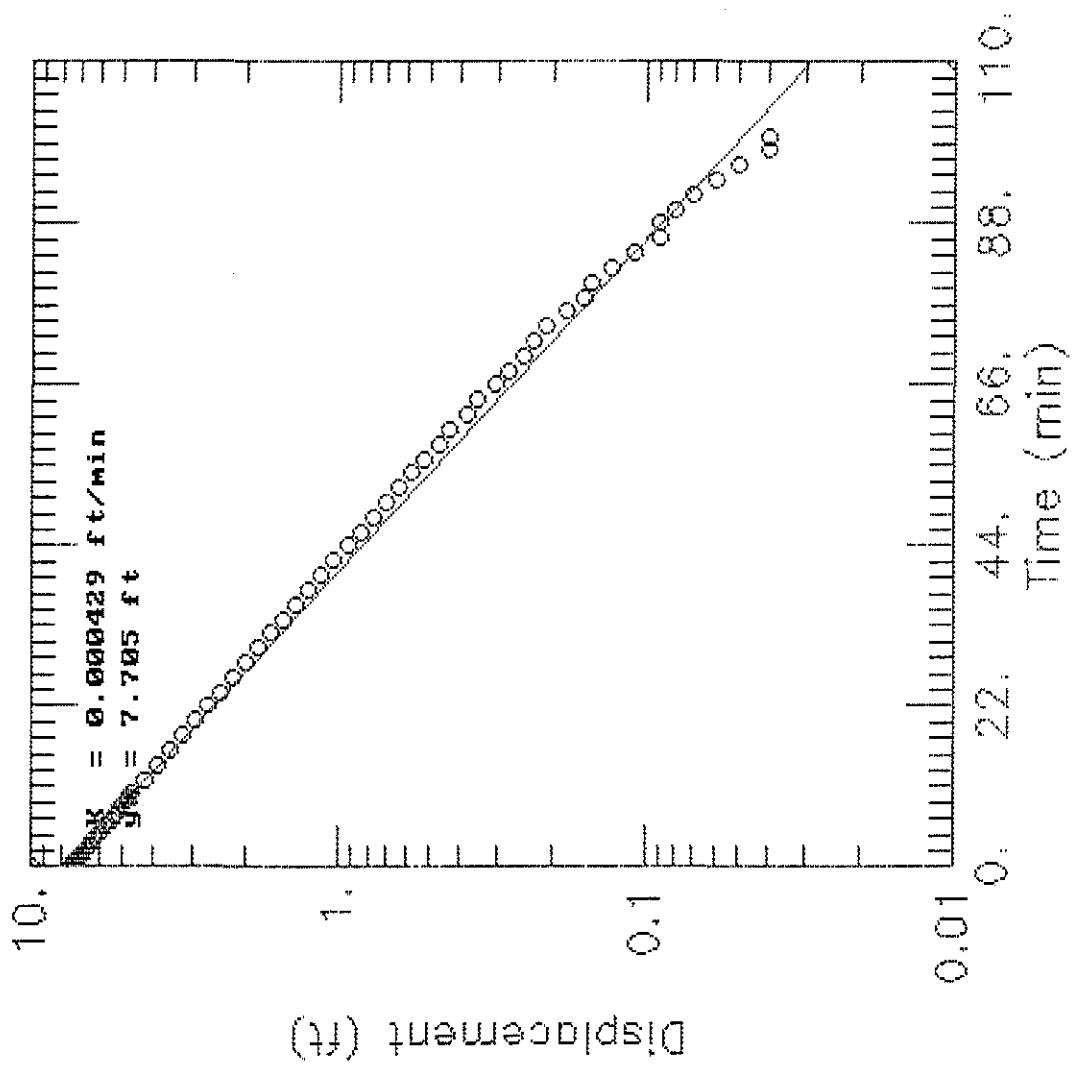
00164

CC-0 Bail Test 1



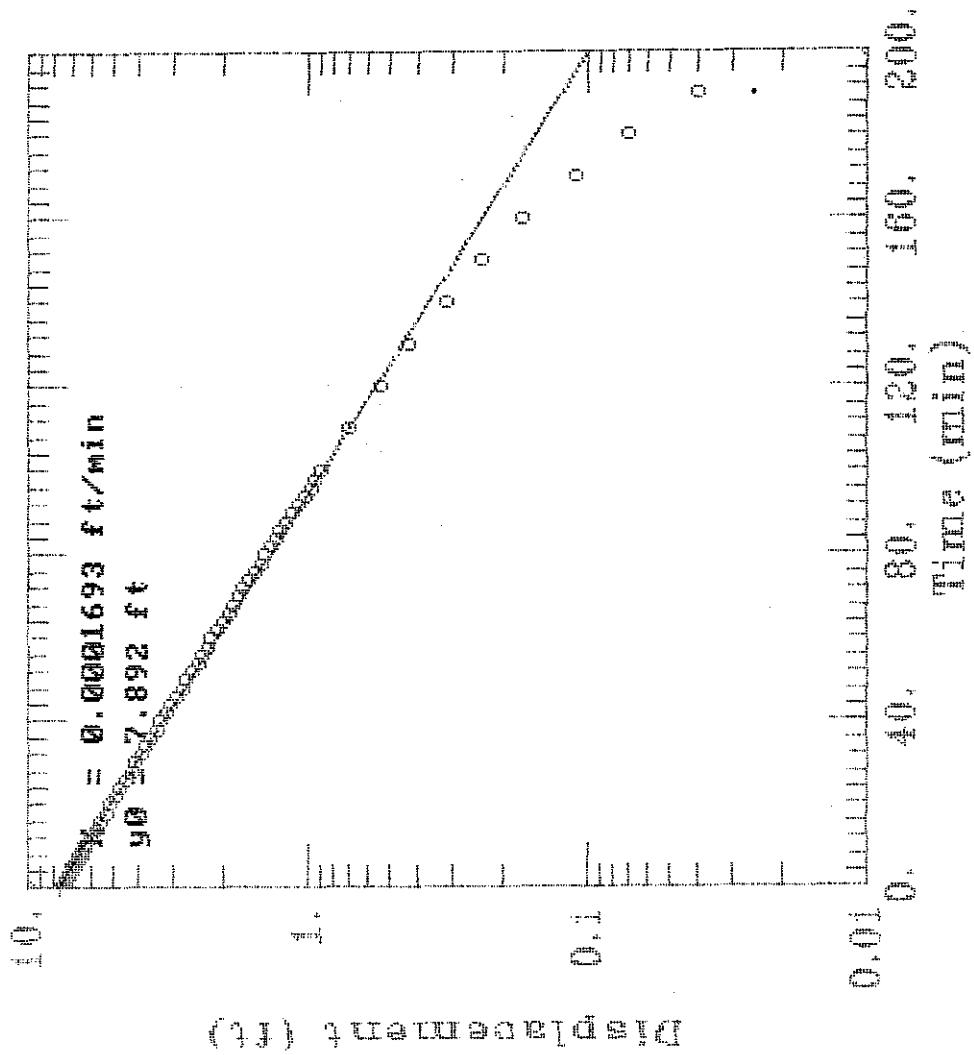
00165

CC-1 Bail Test 1



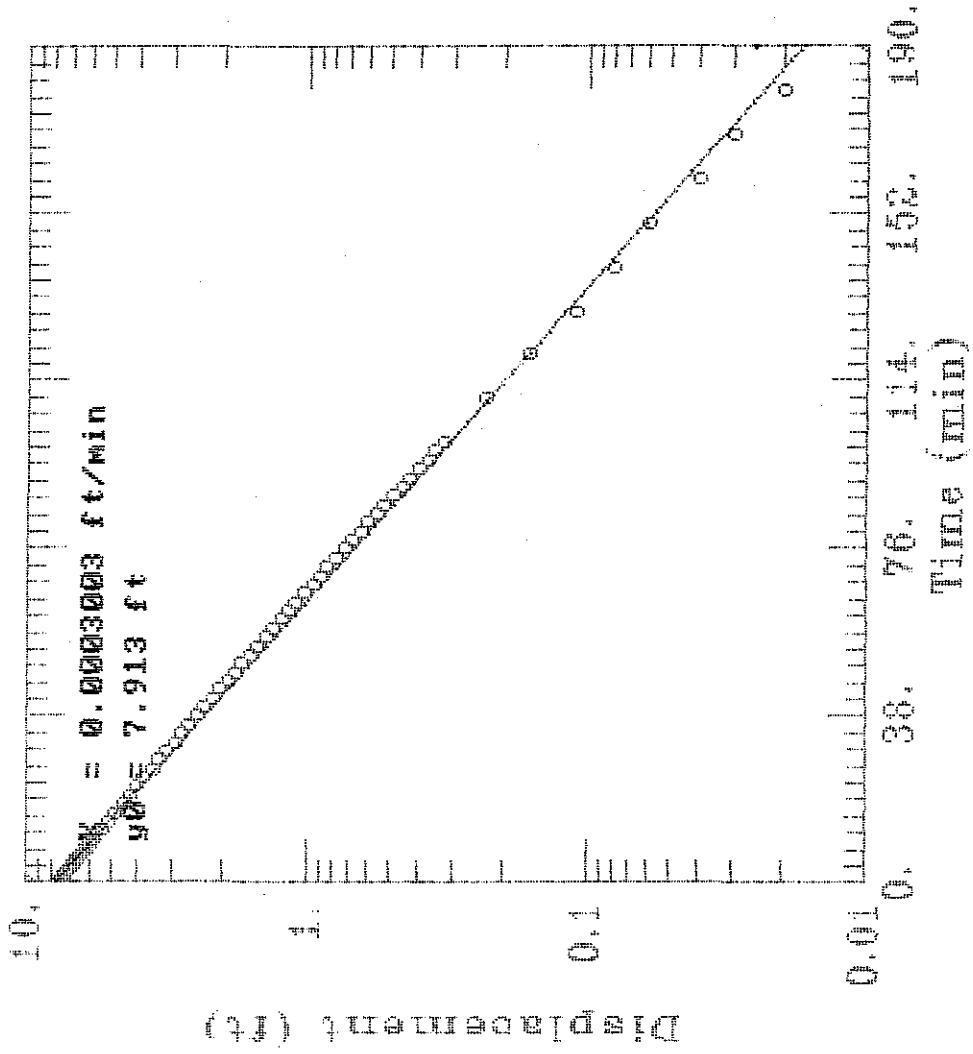
00166

CG-2 Ball Test 1



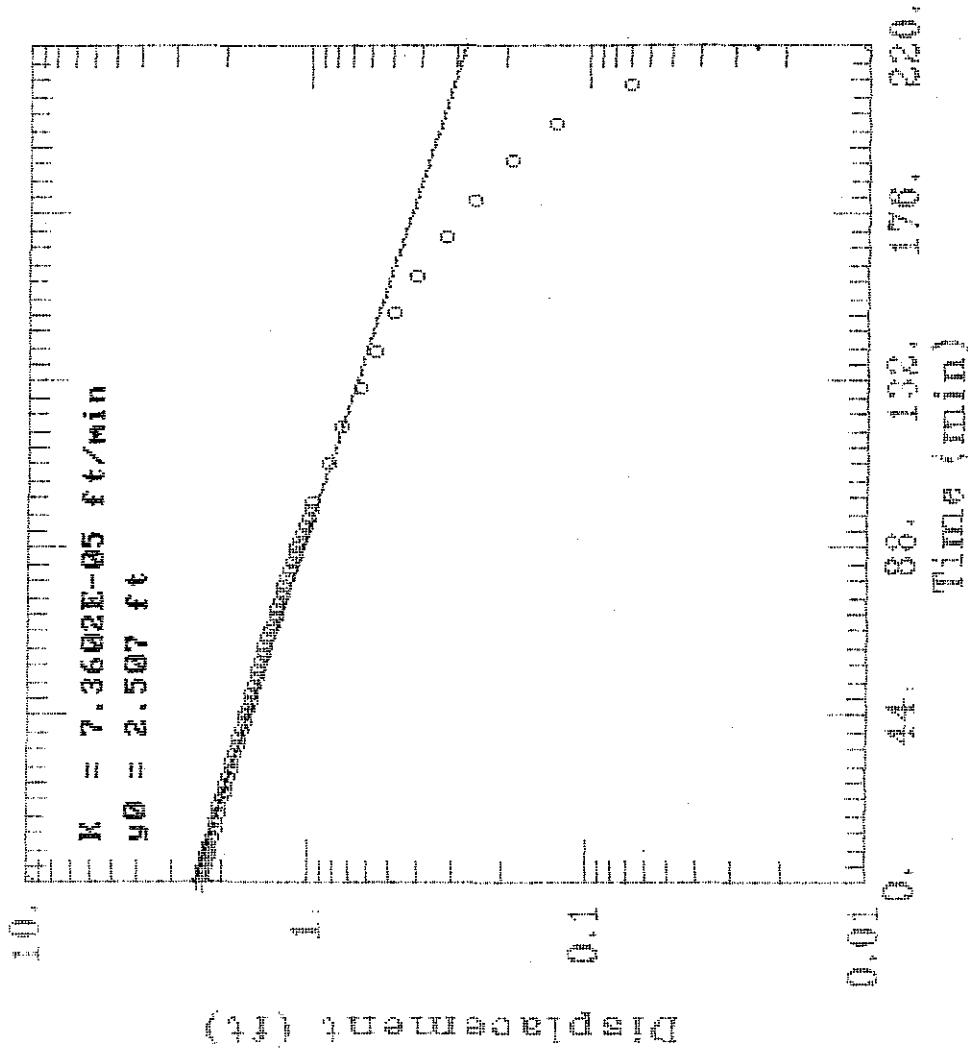
00167

CC-3 Bell Test 1



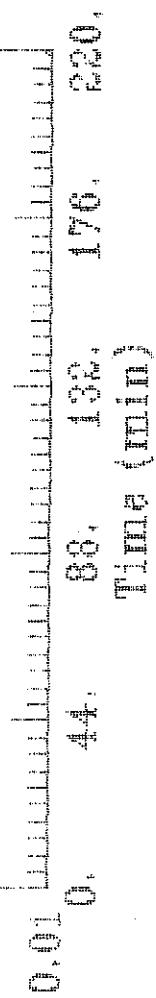
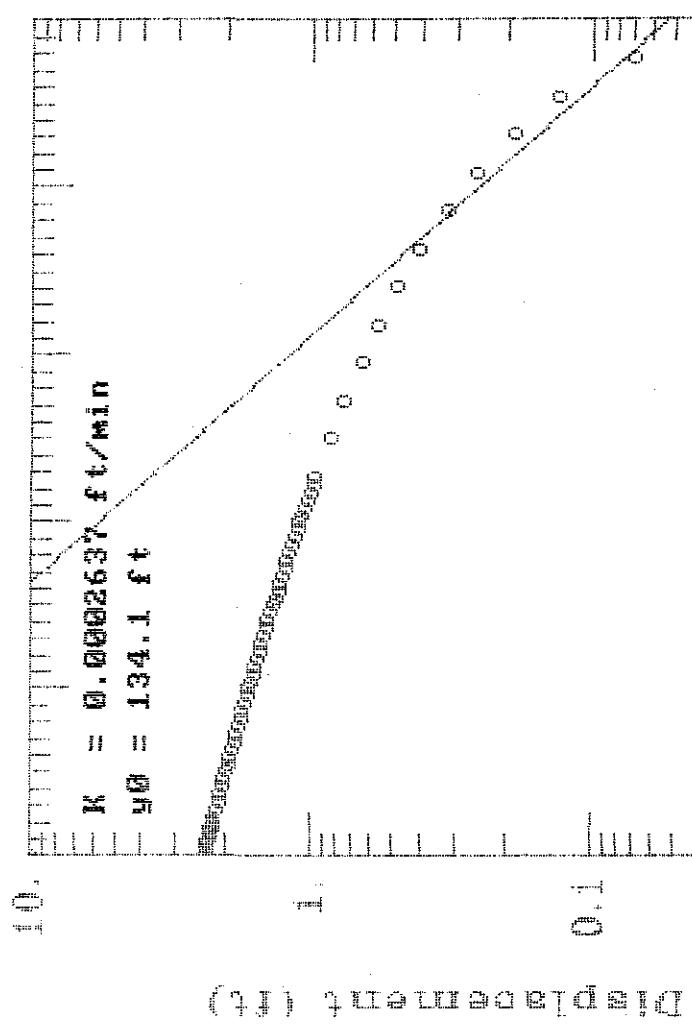
00168

CG-4 Ball Test 1



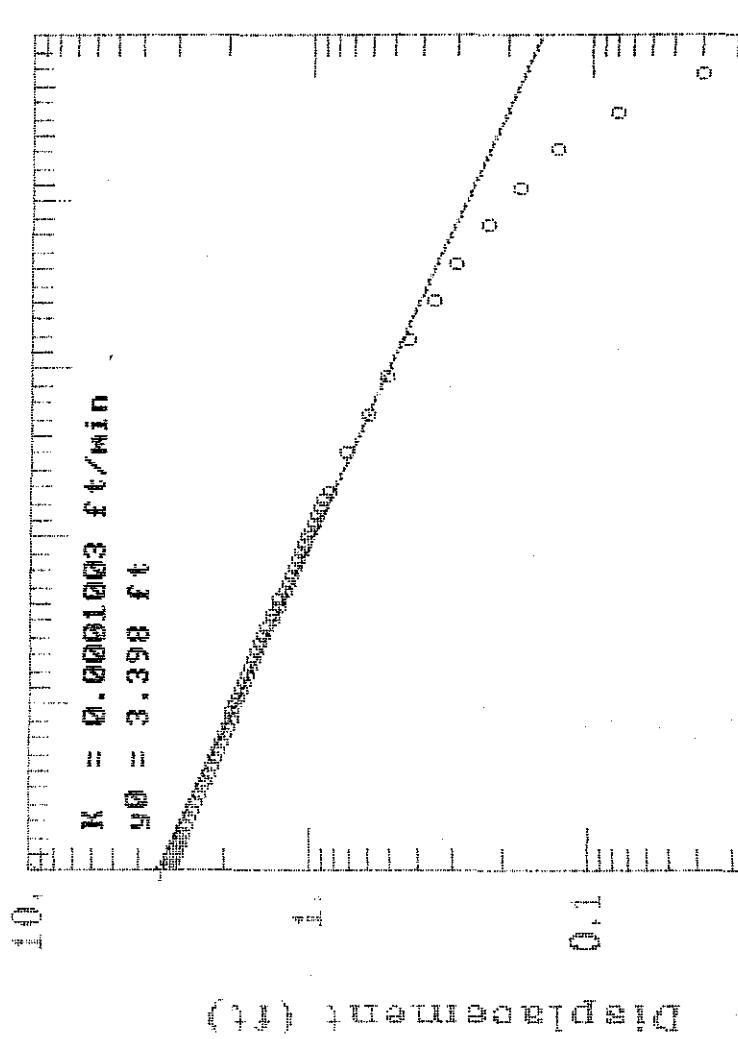
00169

CC-4 Ball Test 1



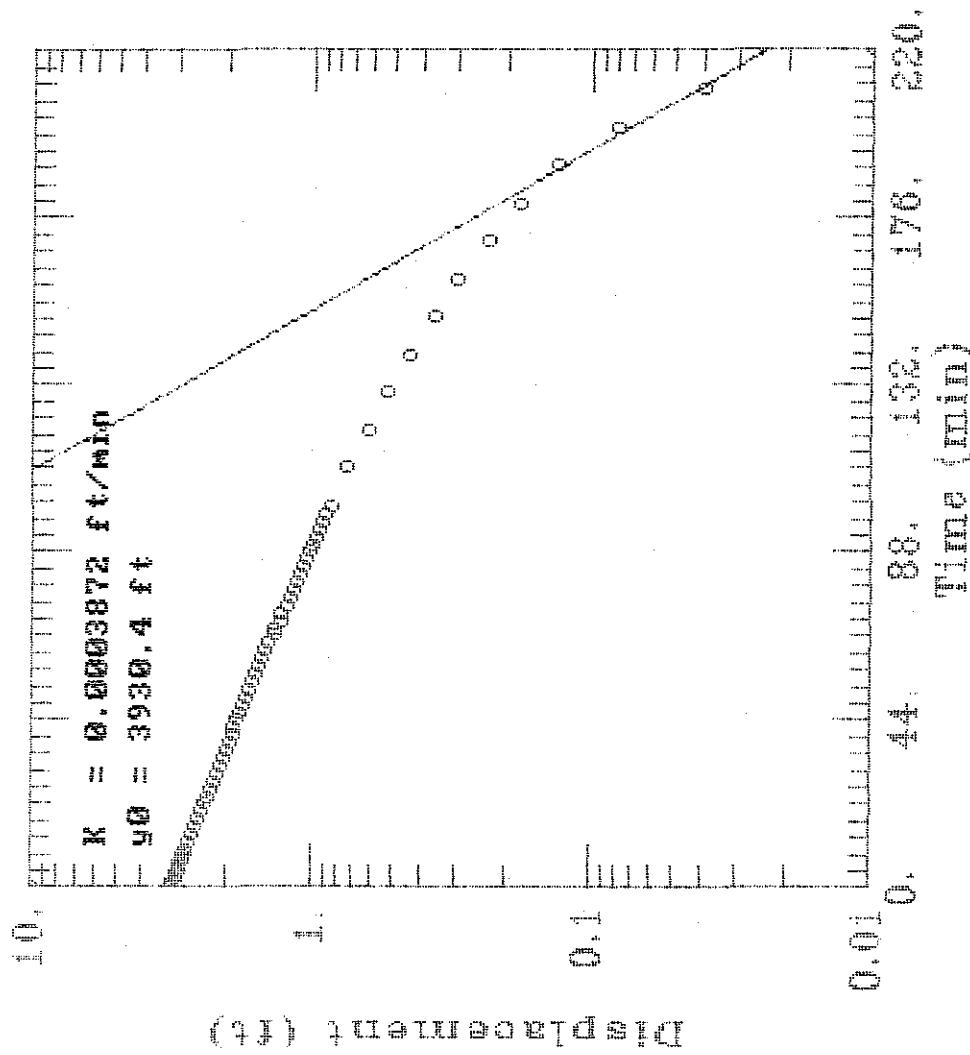
00170

CC-5 Ball Test 1



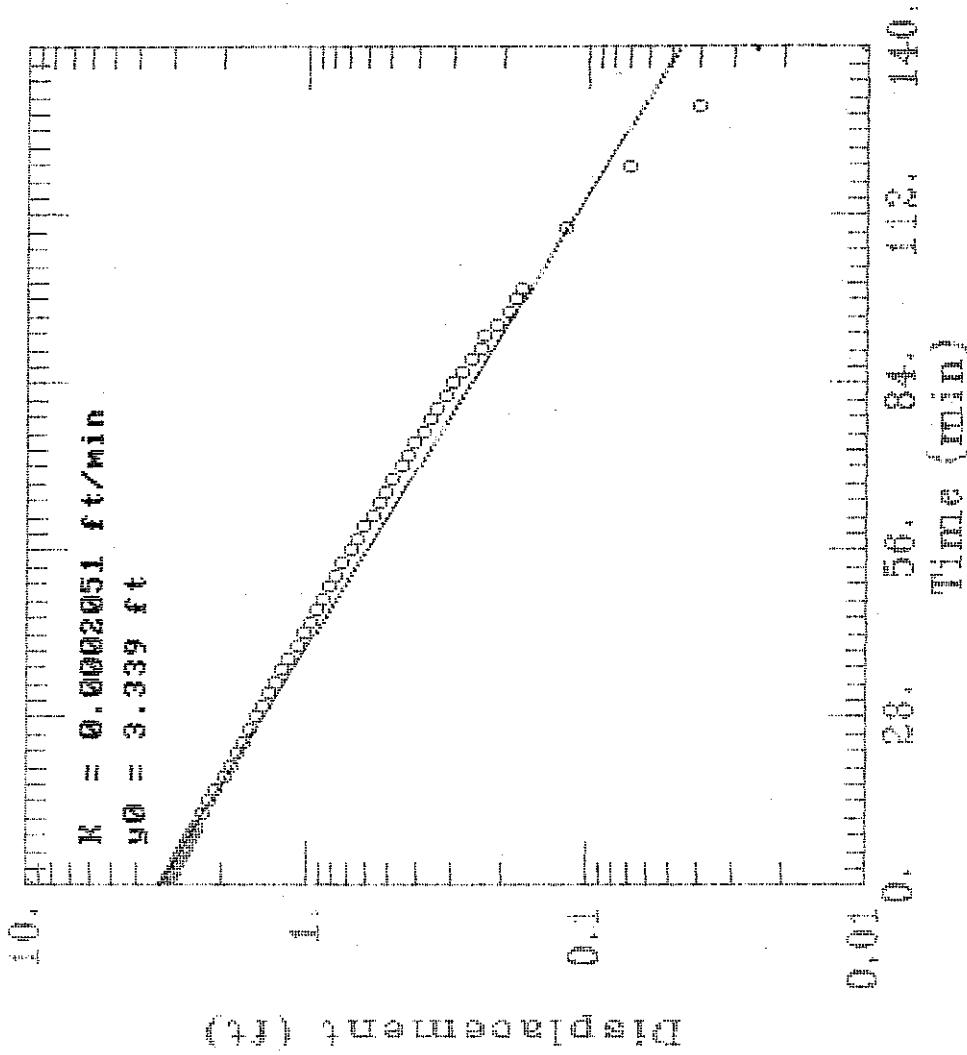
00171

CC-3 E811 Test 1



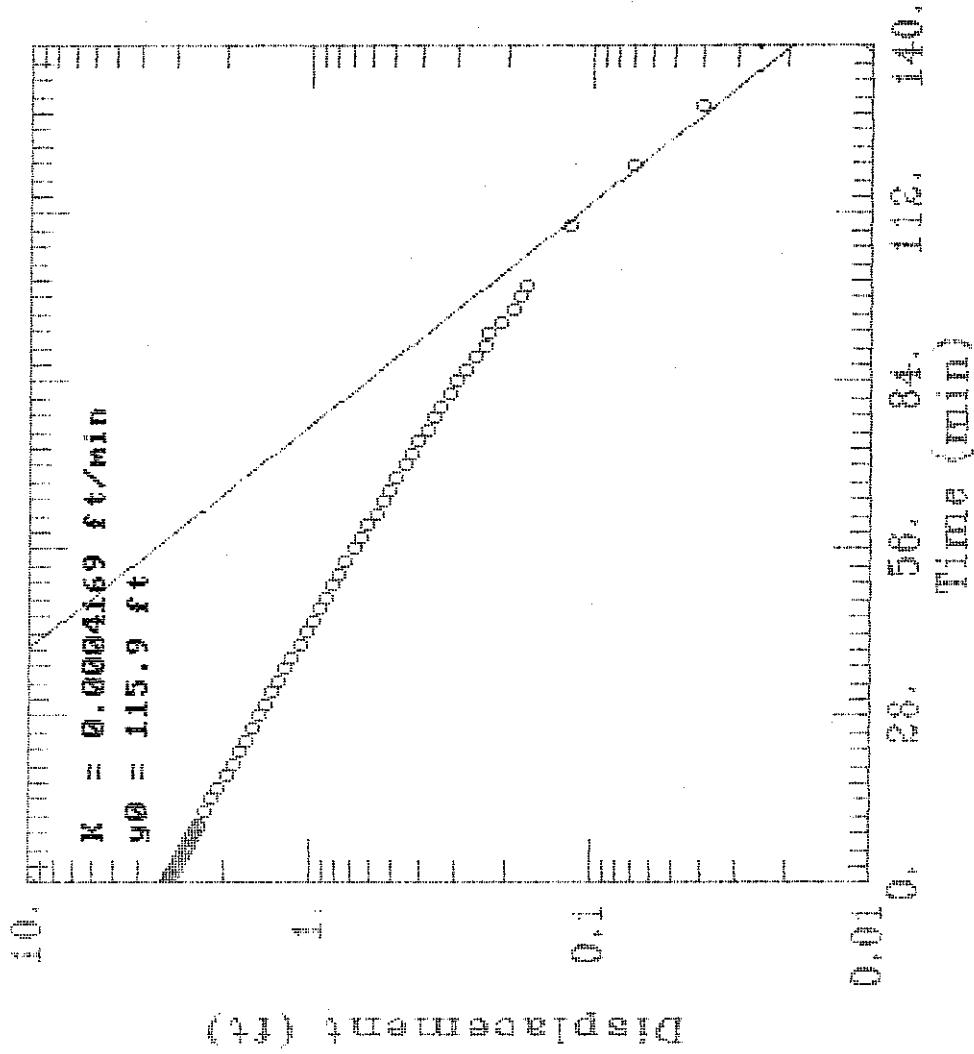
00172

CG-6 Bell Test 1



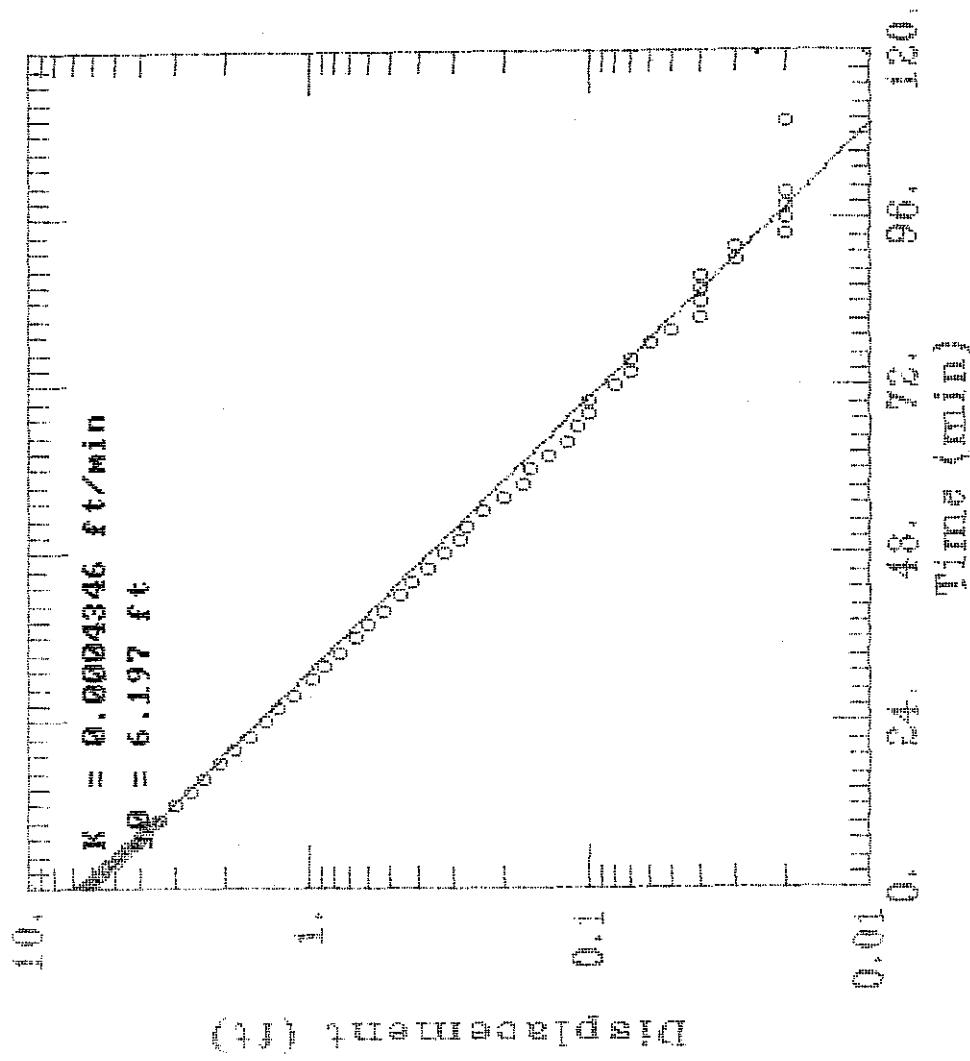
00173

CC-6 Ball Test 1



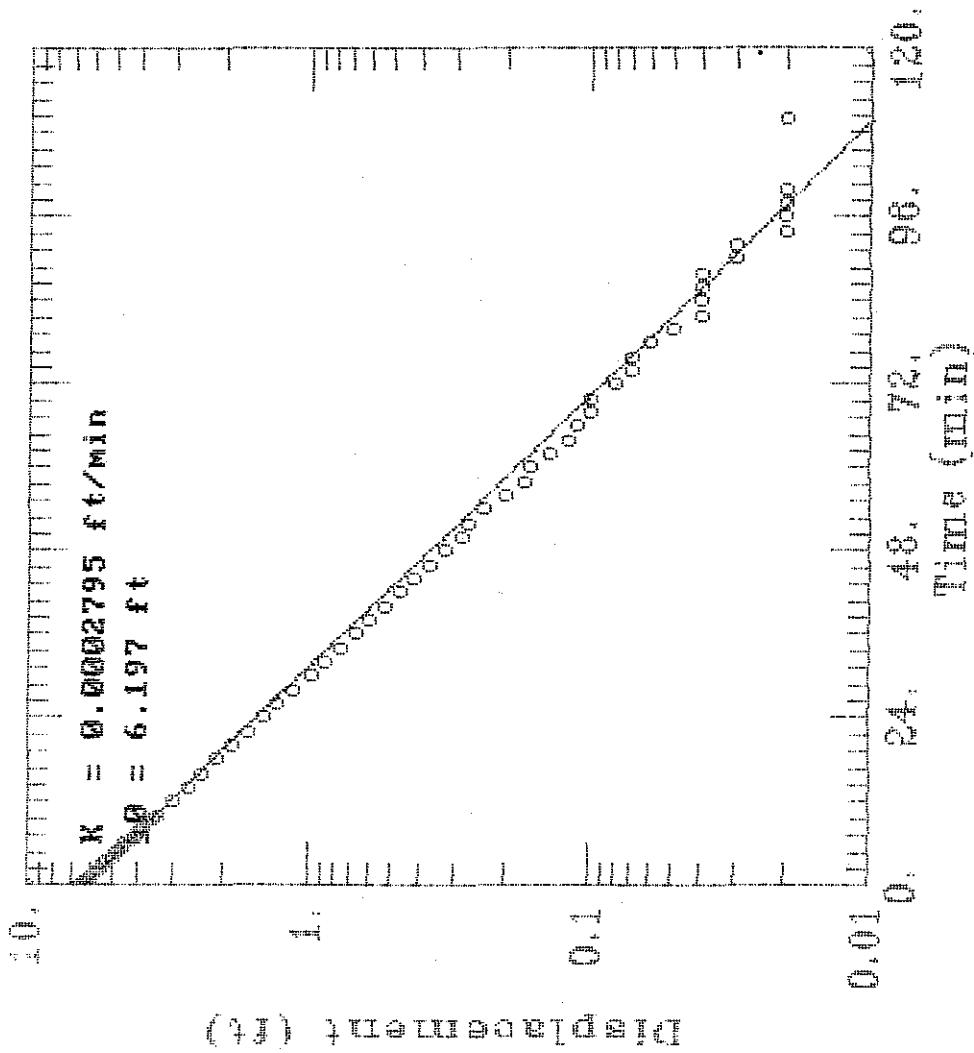
00174

CC-7 Dail Test 1



00175

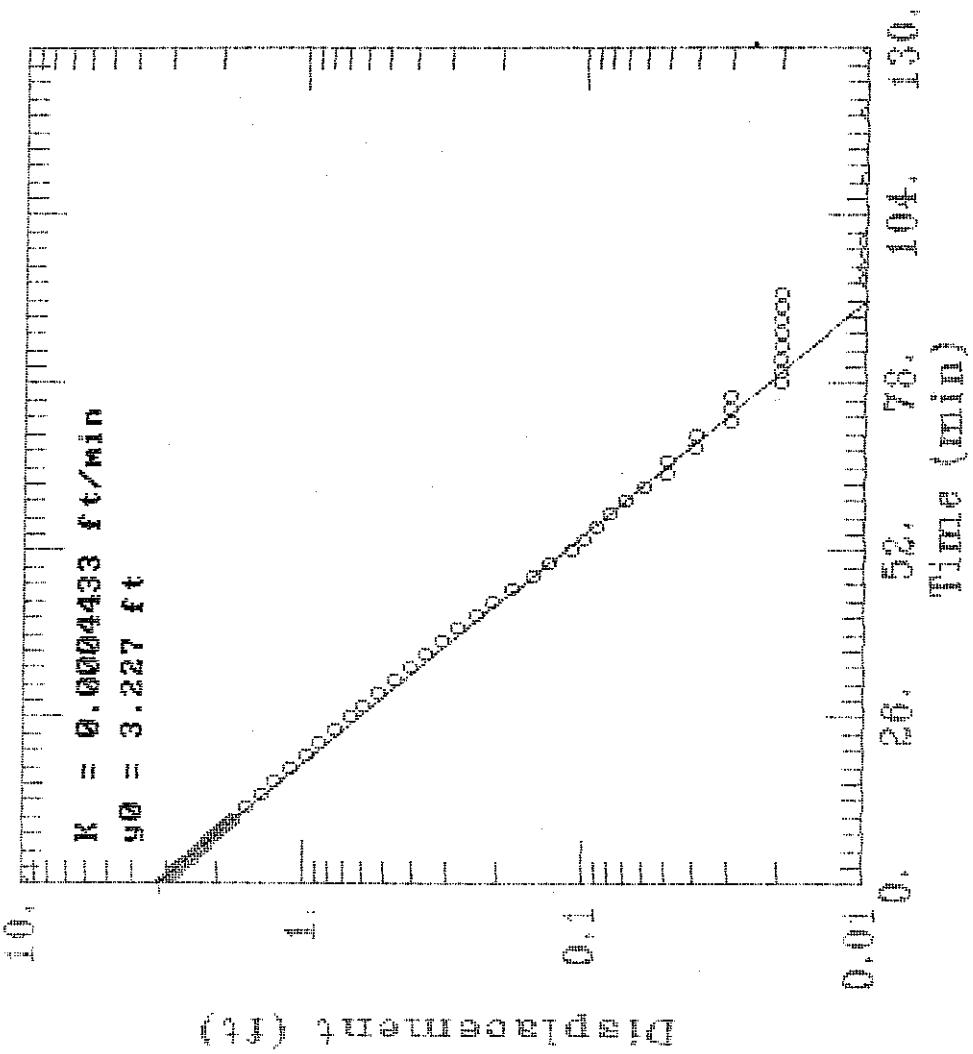
CG-7 Fall Test I



U.S. Army
Corps of Engineers
Waterways Experiment Station

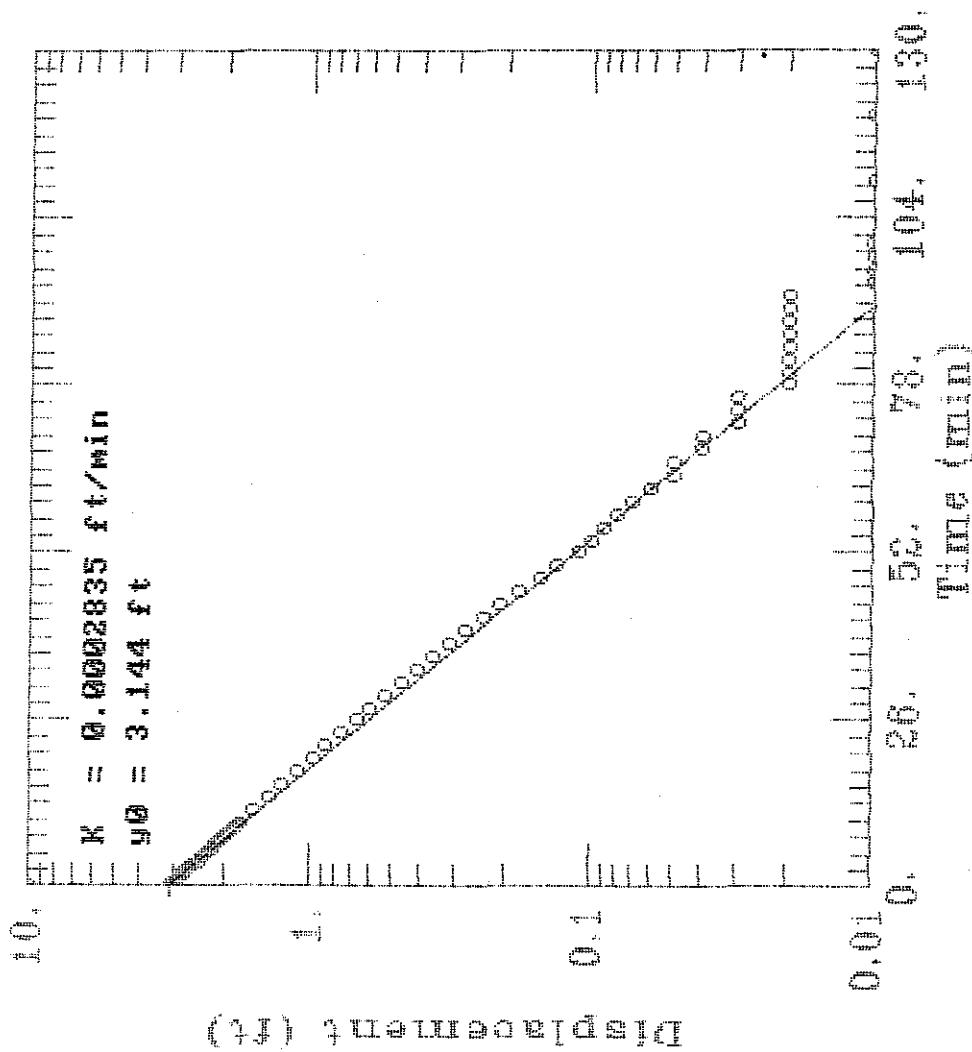
00176

CC-8 Bell Test 1



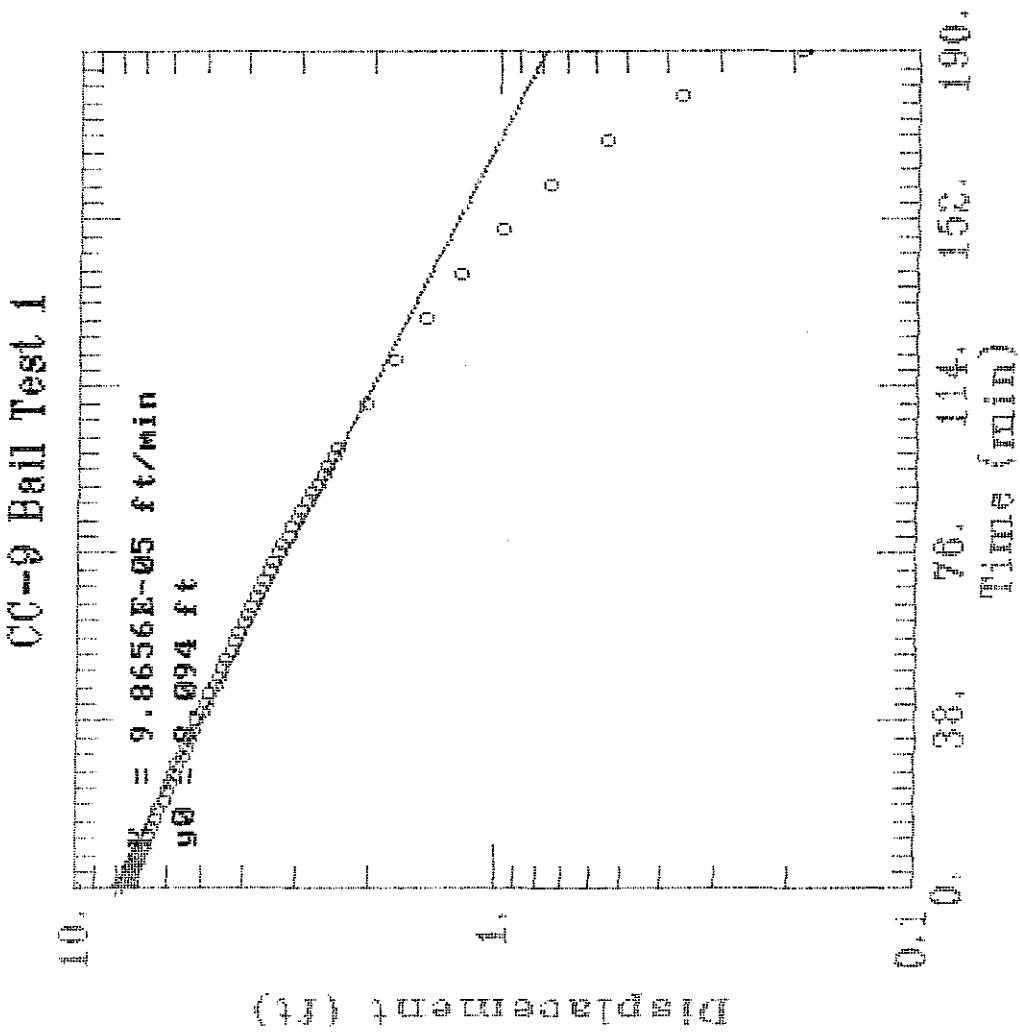
00177

CC-B Ball Test 1



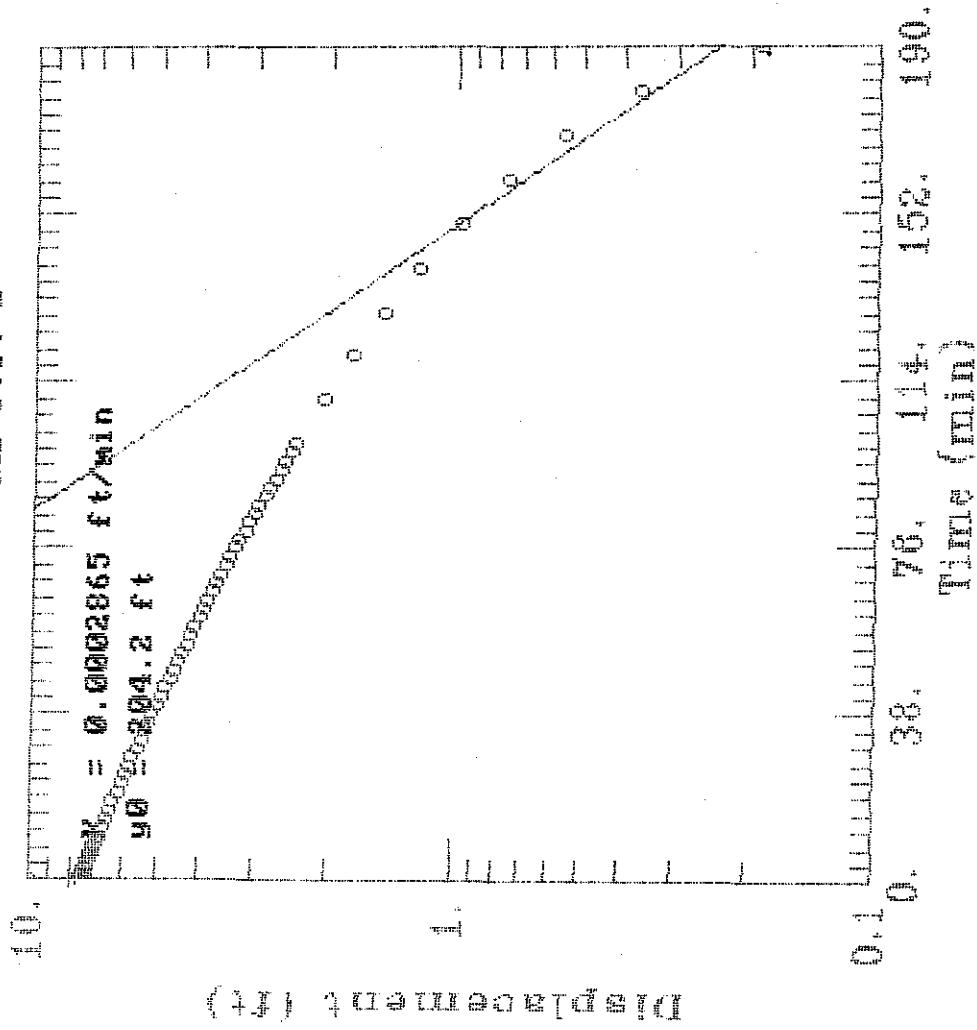
Unit of measurement
inches per second

00178



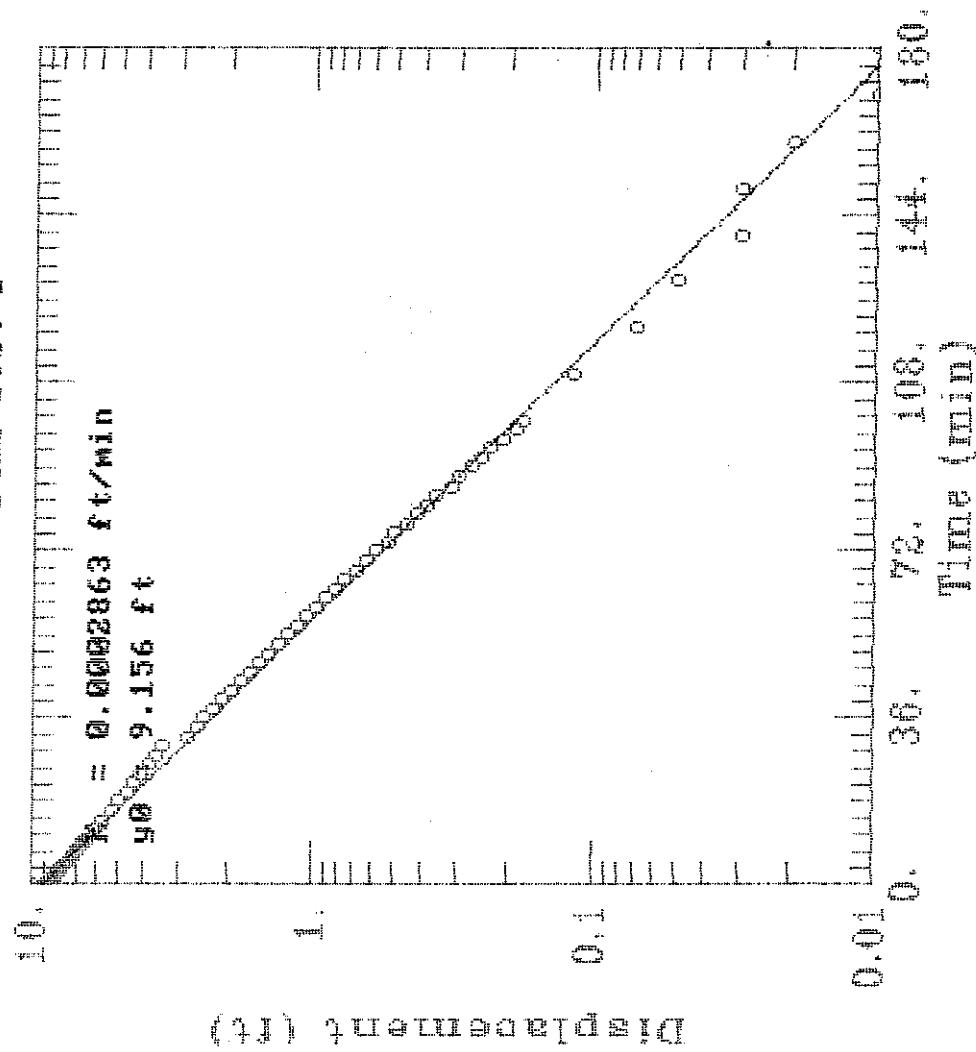
00179

CC-0 Ball Test 1



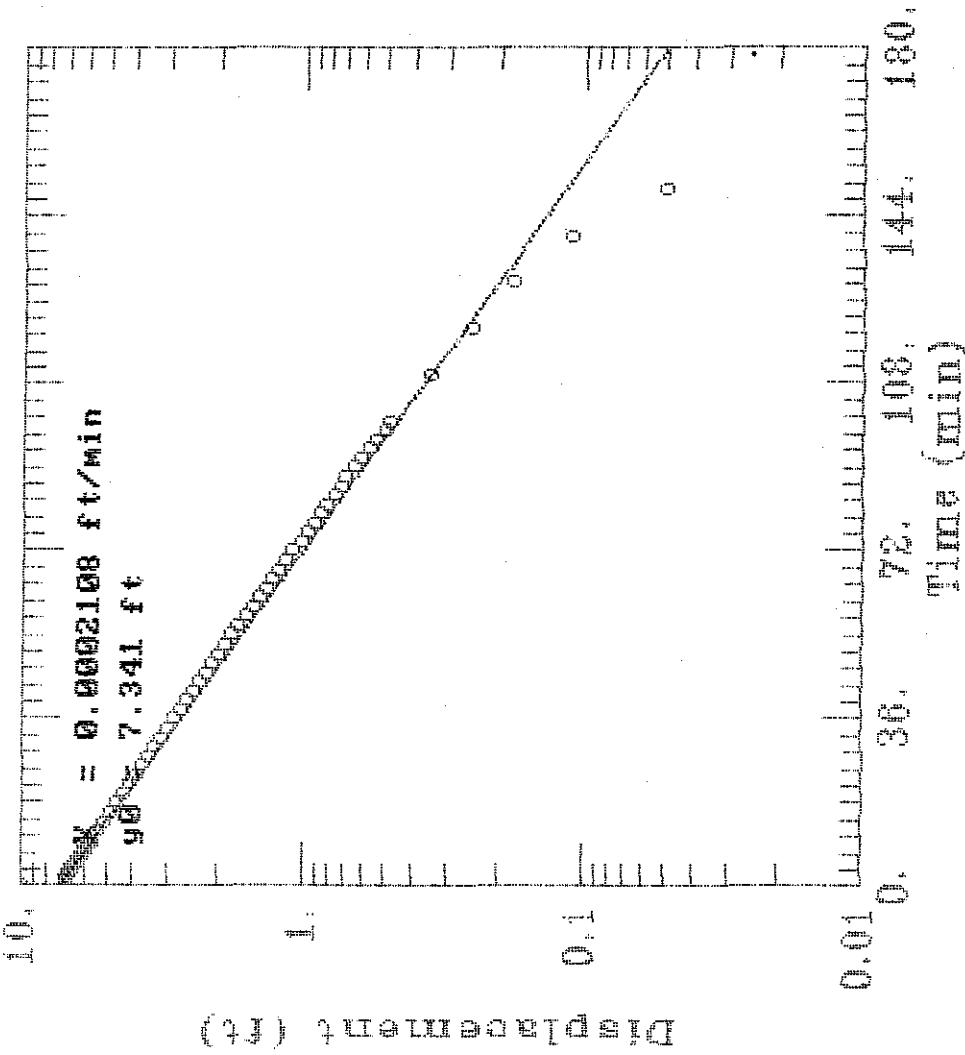
00180

CC-10 Ball Test 1



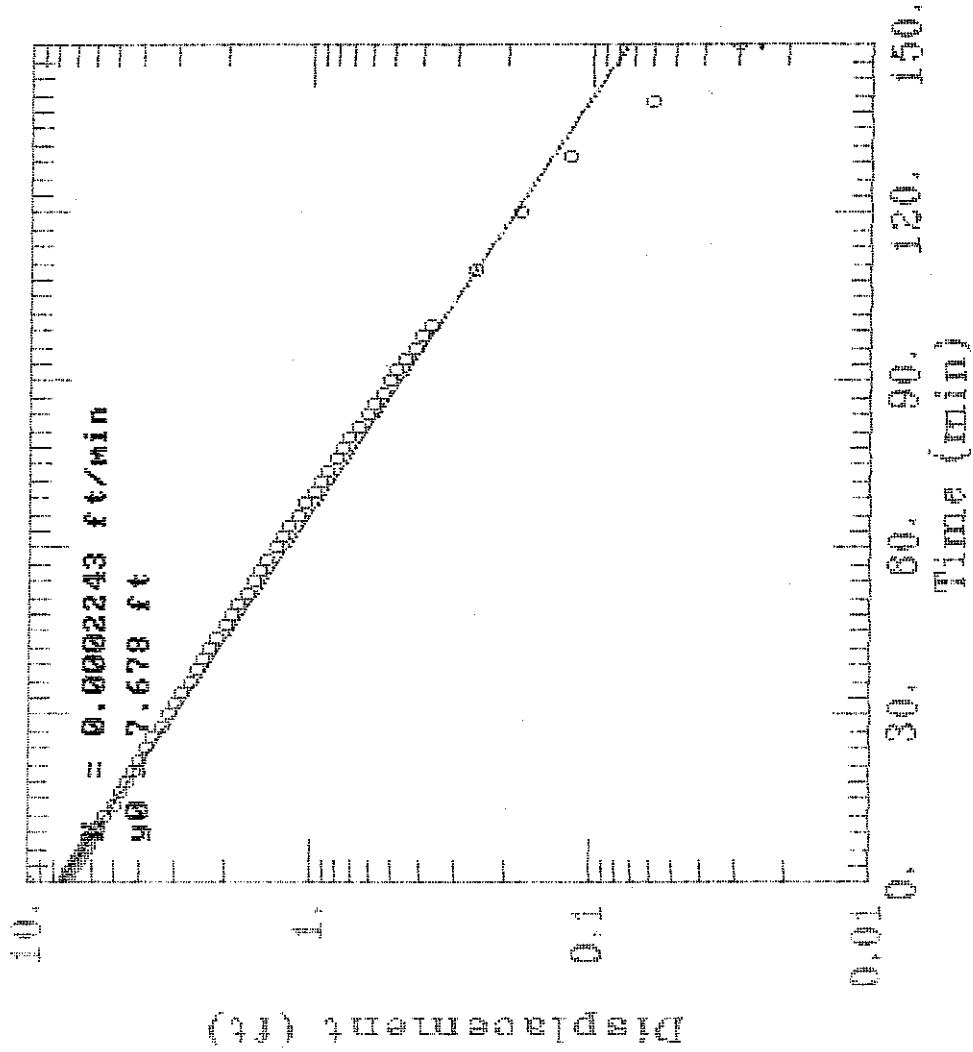
00181

CC-11 Ball Test 1



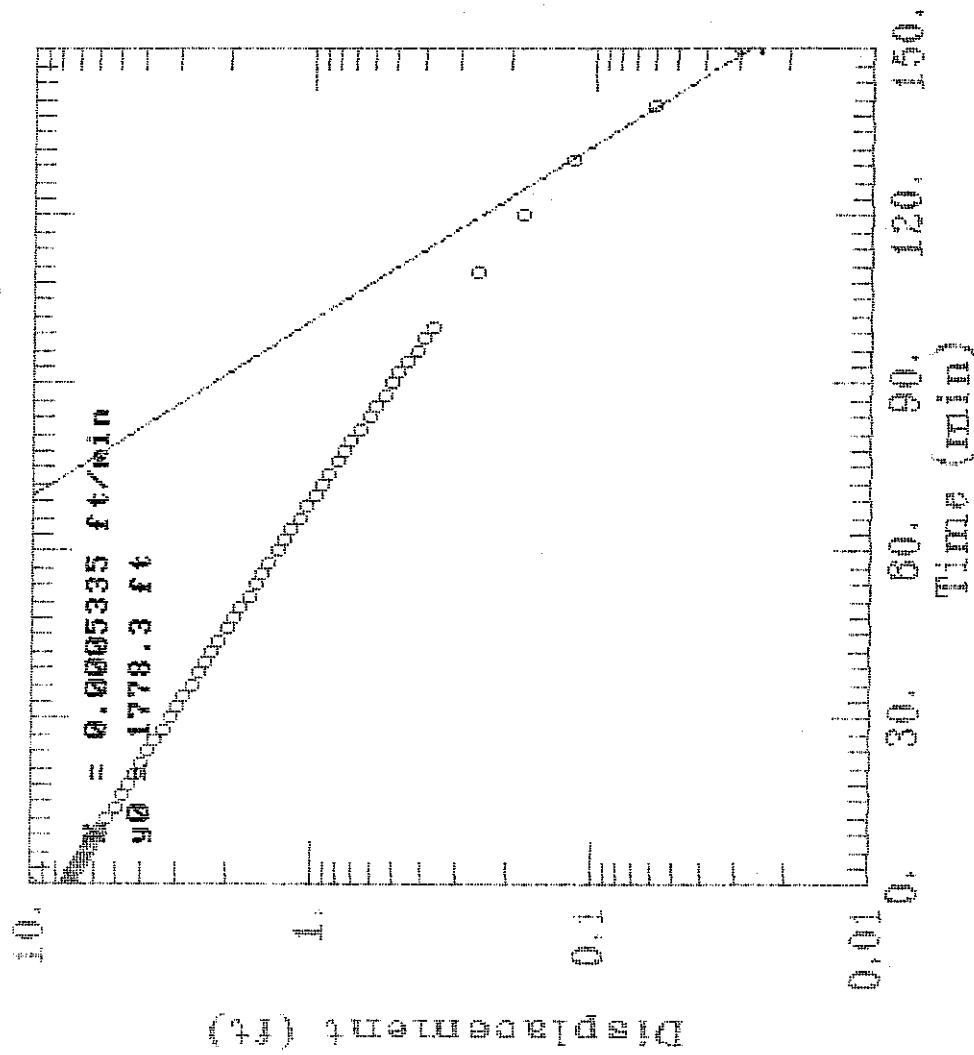
00182

CC-18 Ball Test 1



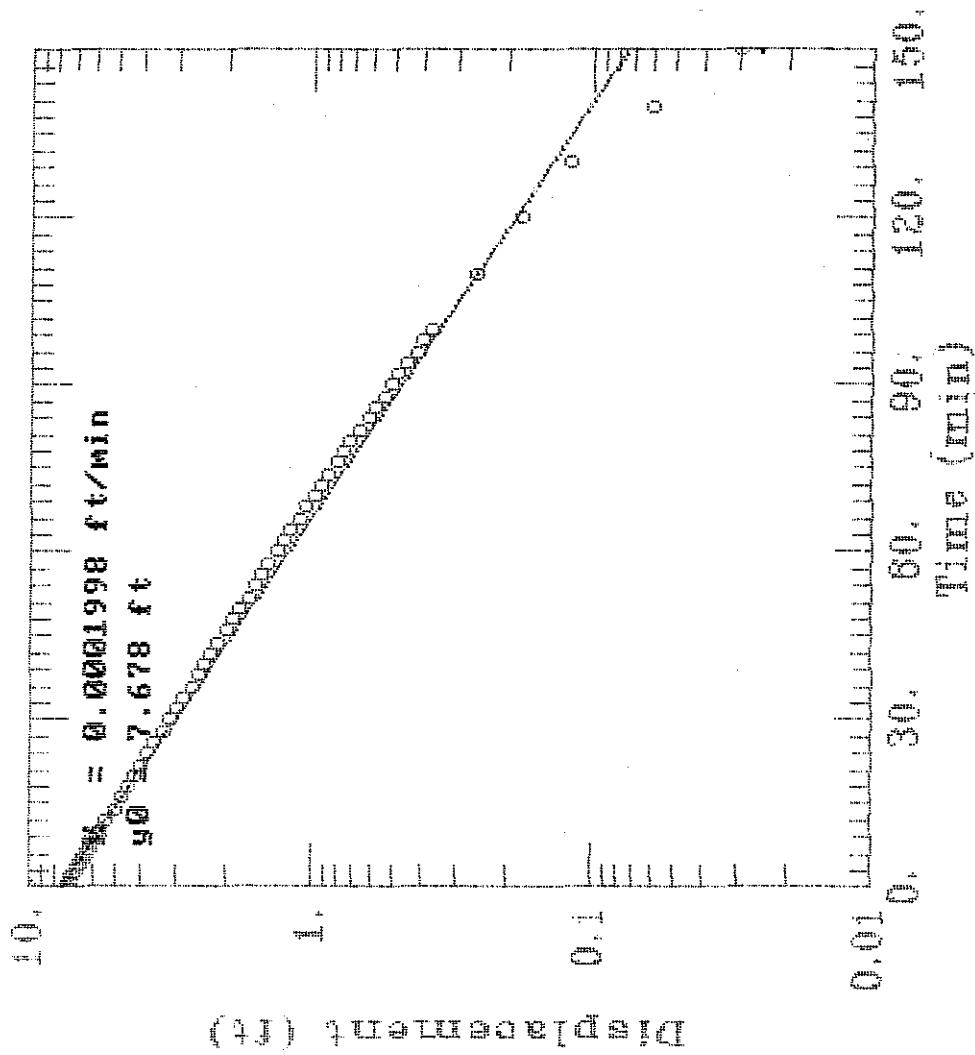
00183

CC-18 Ball Test 1

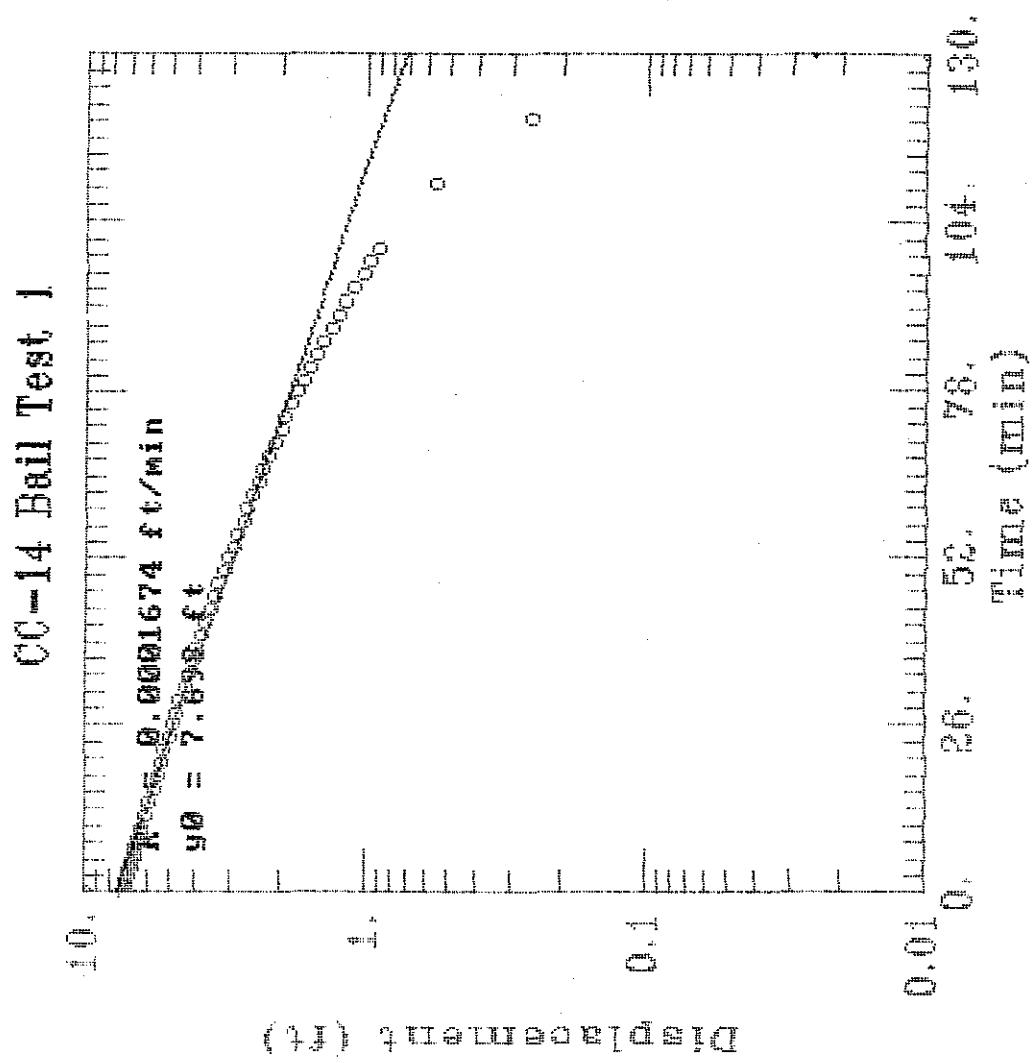


00184

CC-13 Ball Test 1

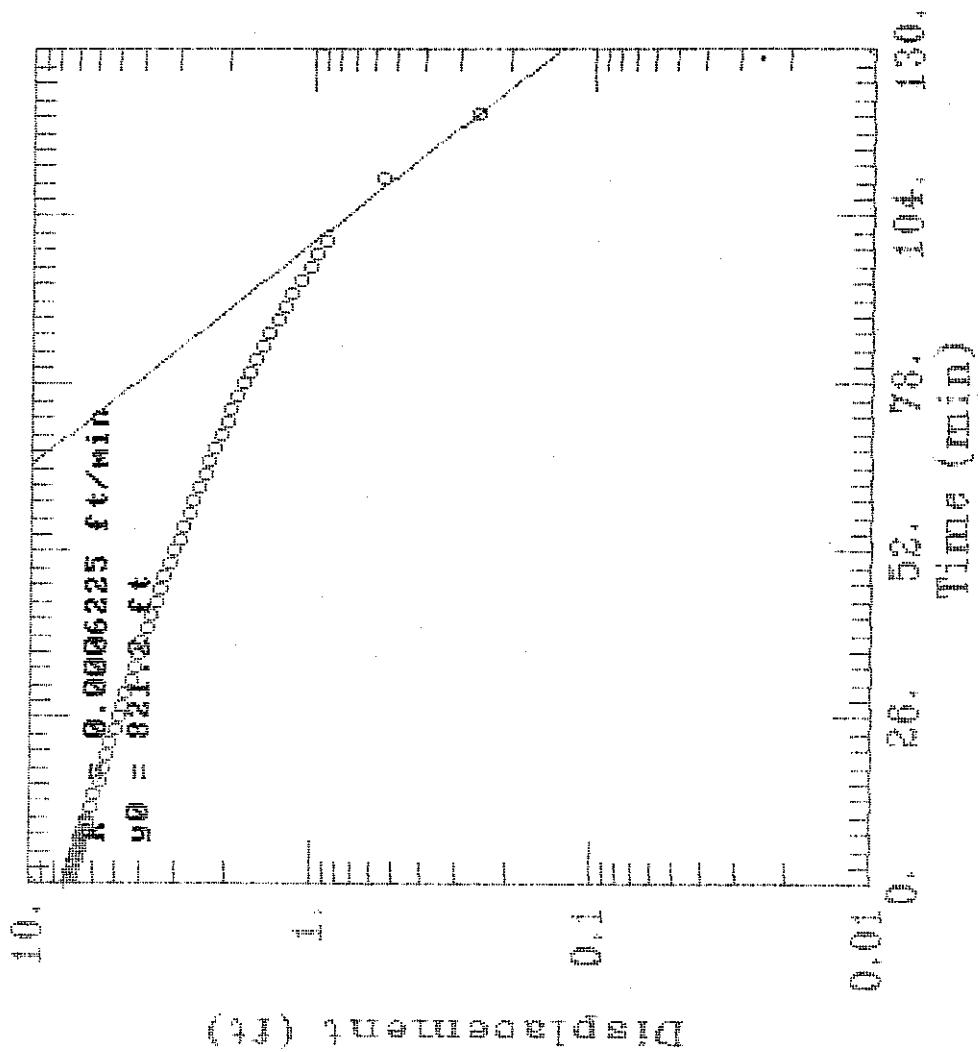


00185



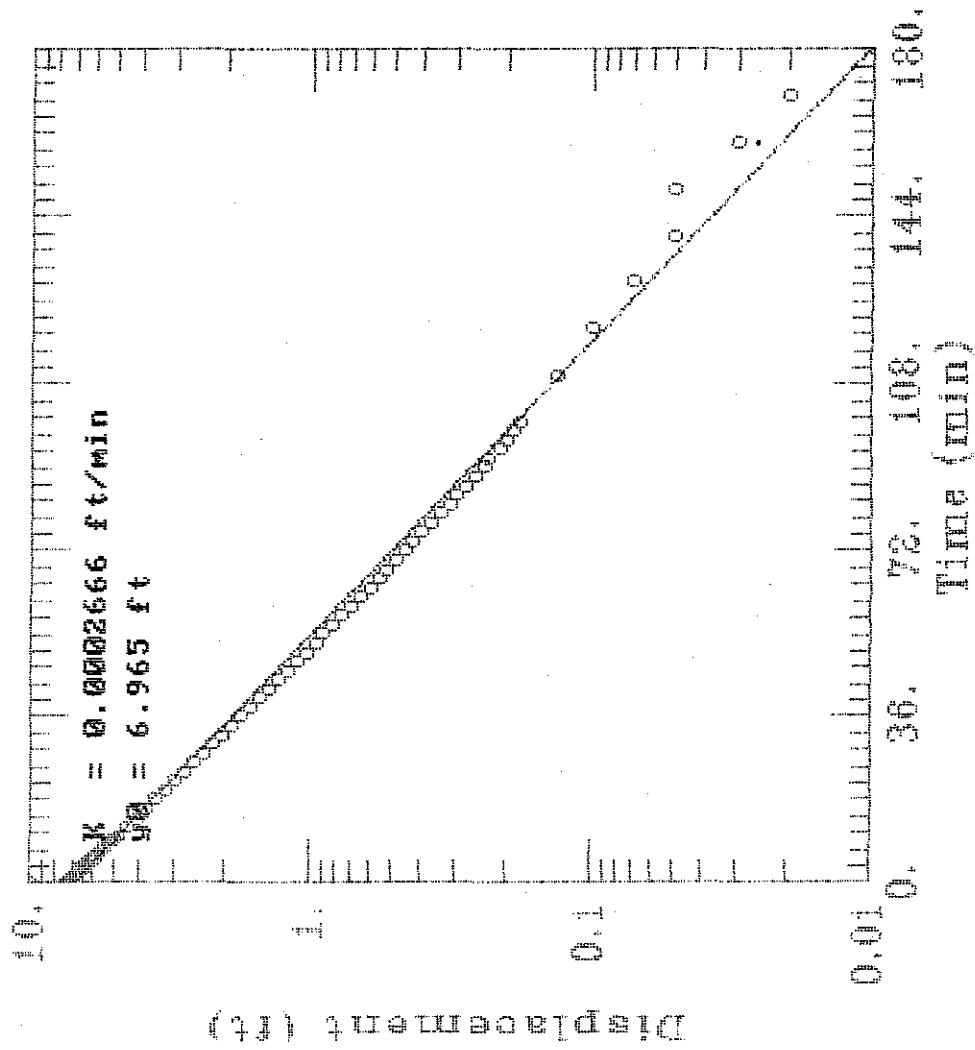
00186

CC-14 Ball Test 1



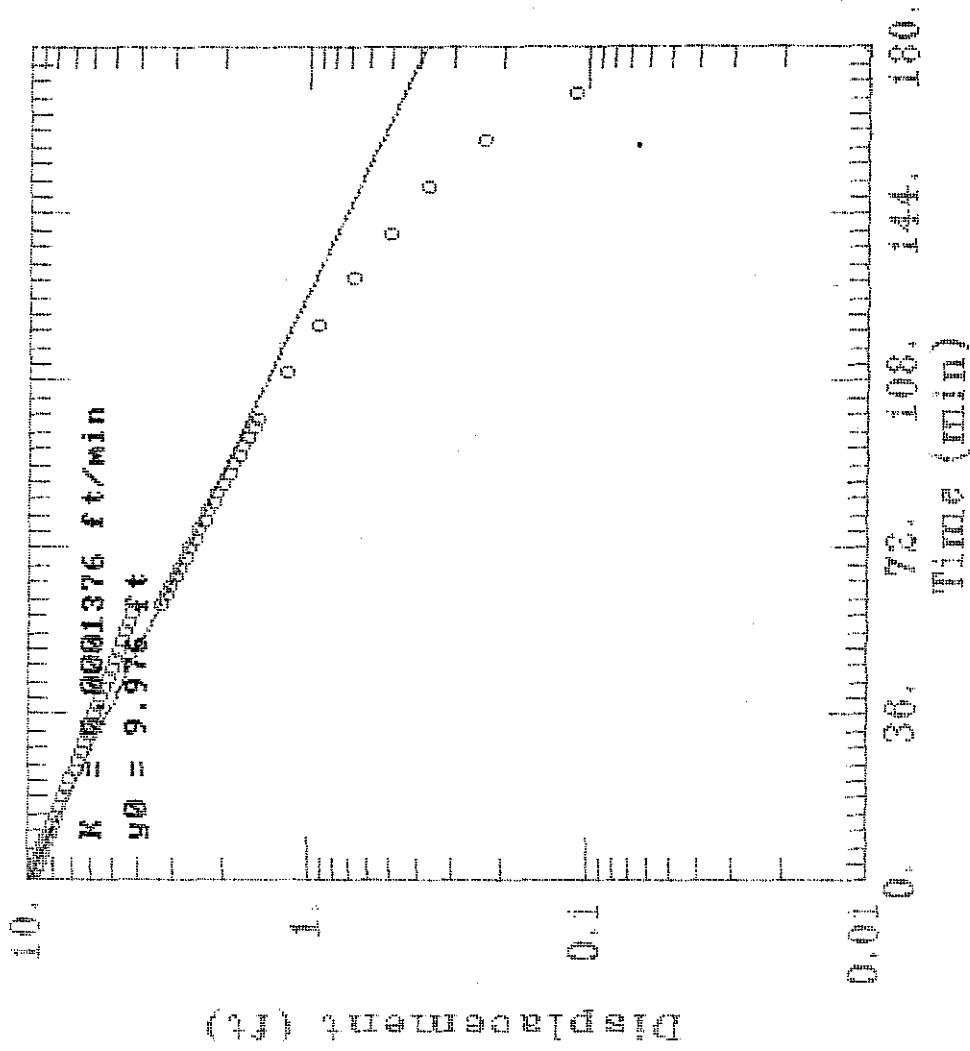
00187

CC-15 Bail Test 1



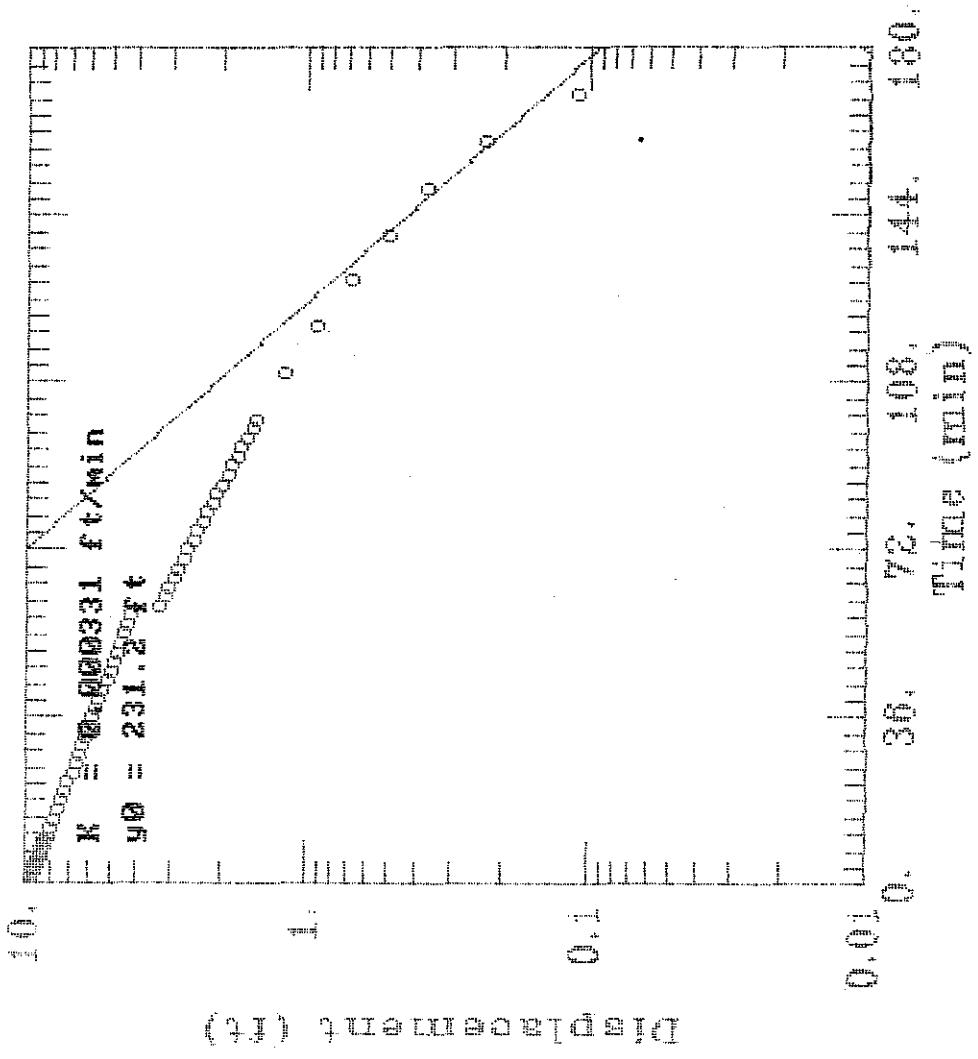
00188

CC-16 Bell Test 1



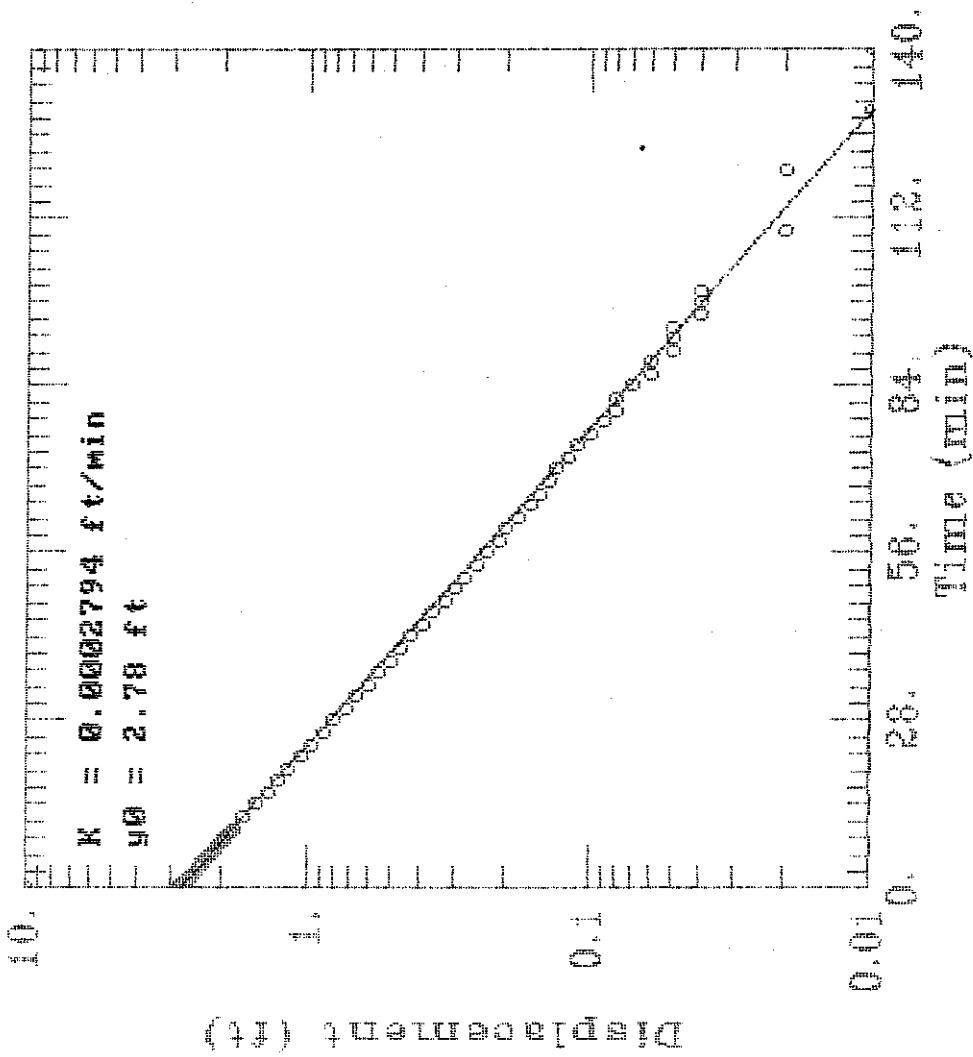
00189

CC-16 Ball Test 1



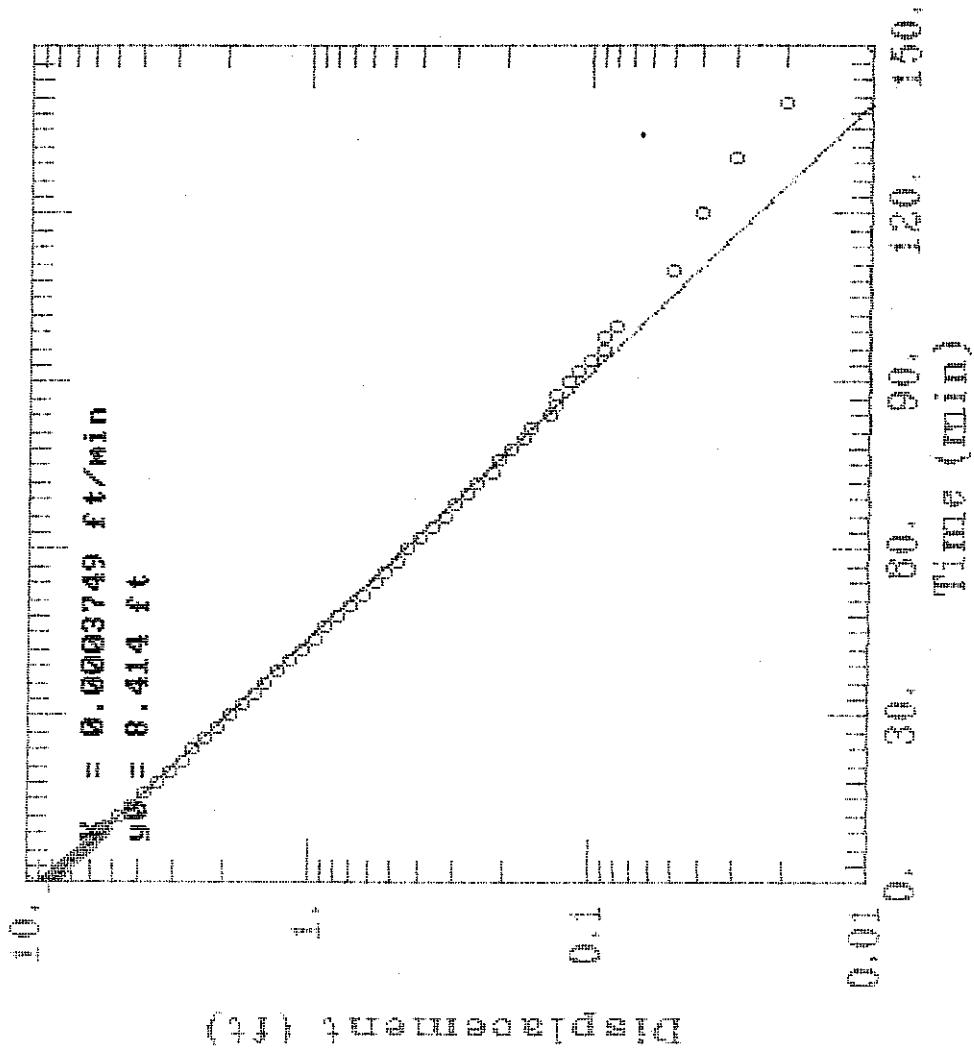
00190

CG-17 Bail Test 1



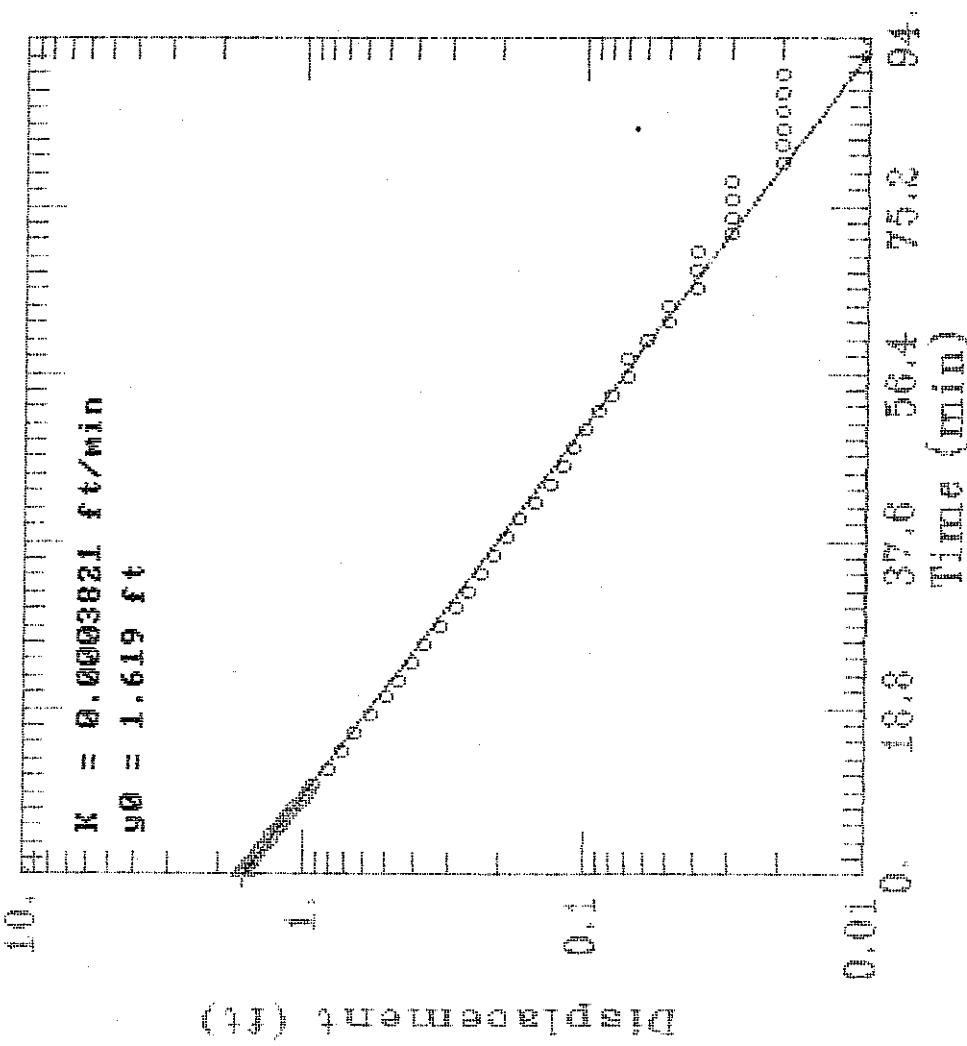
00191

CC-18 Ball Test 1



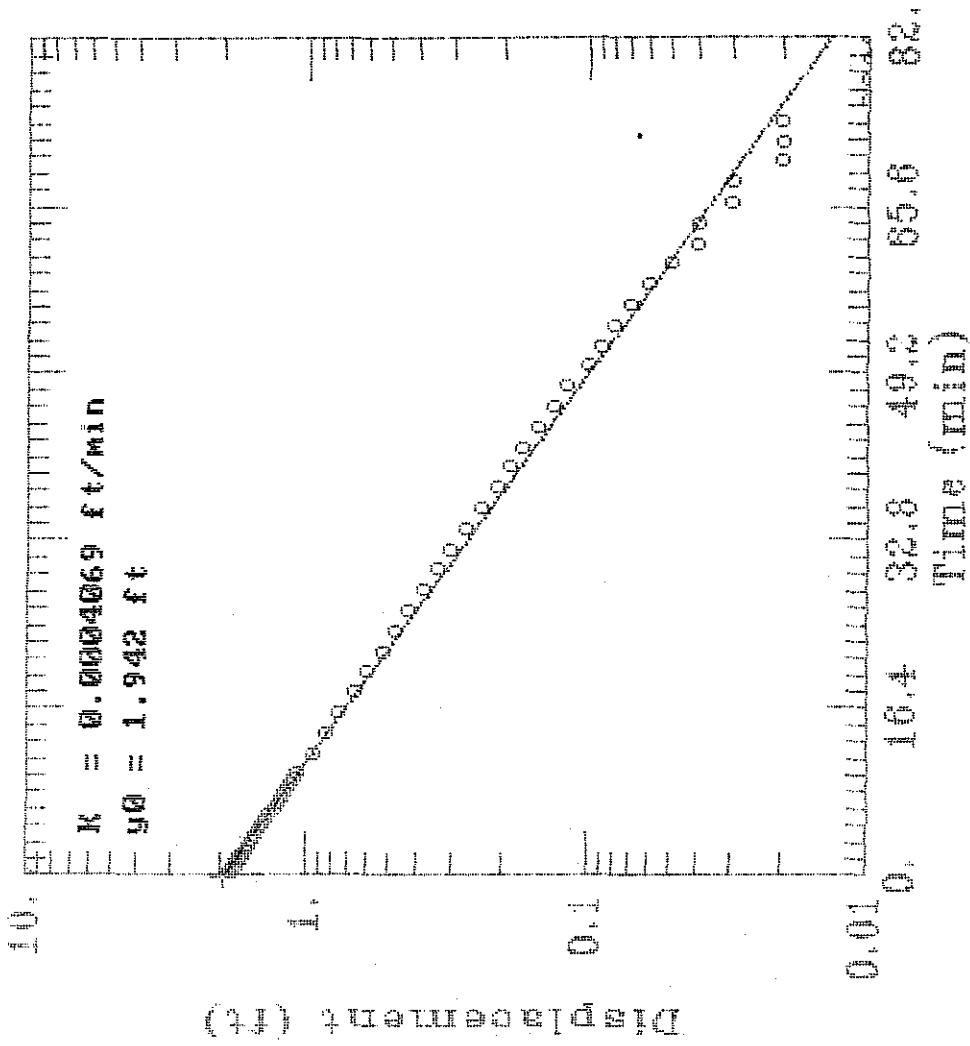
00192

CC-19 Ball Test 1



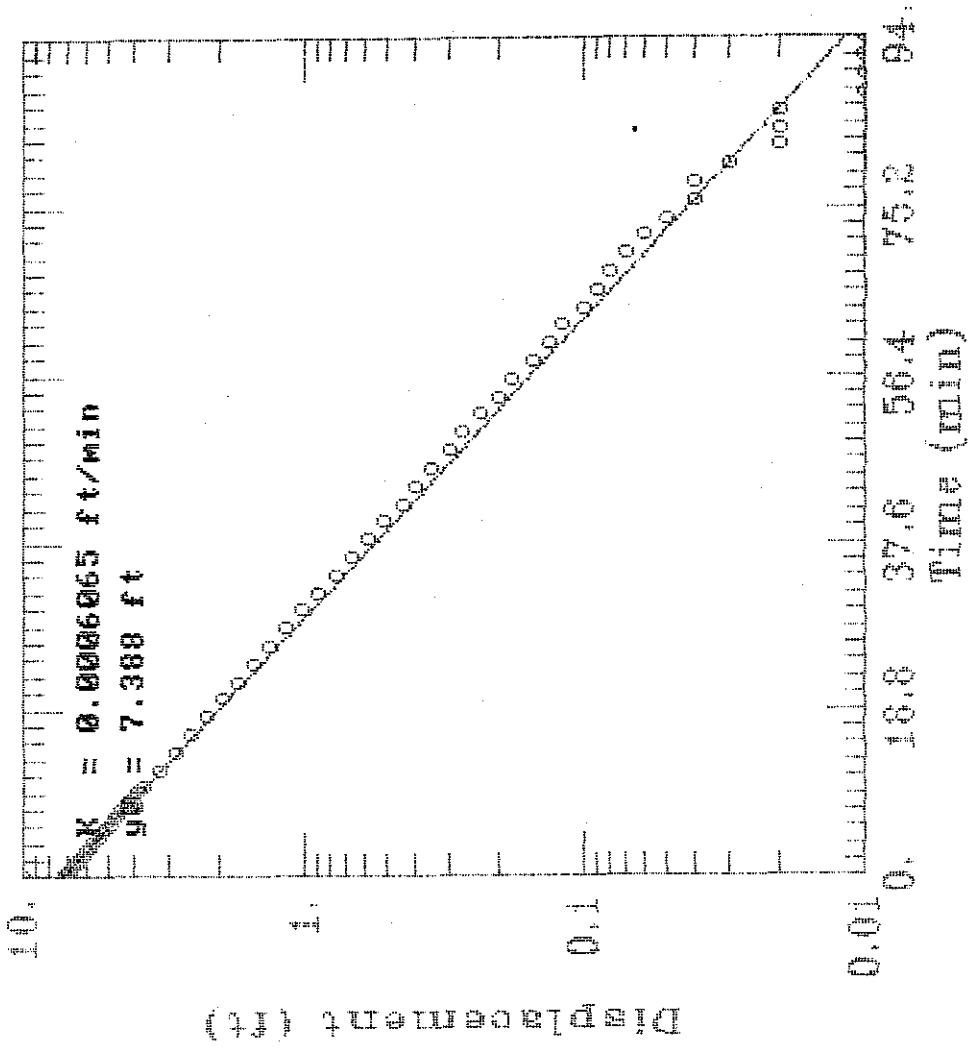
00193

CC-20 Bail Test 1



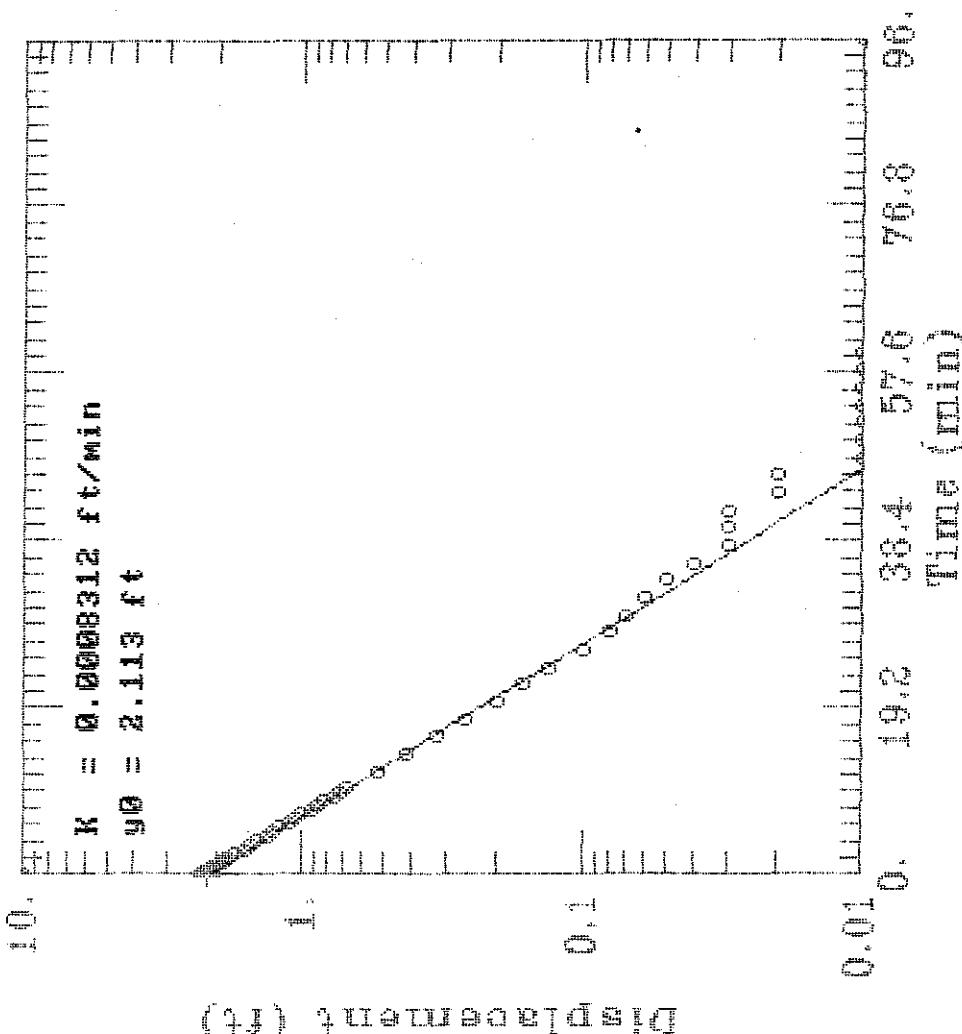
00194

CC-21 Fall Test 1



00195

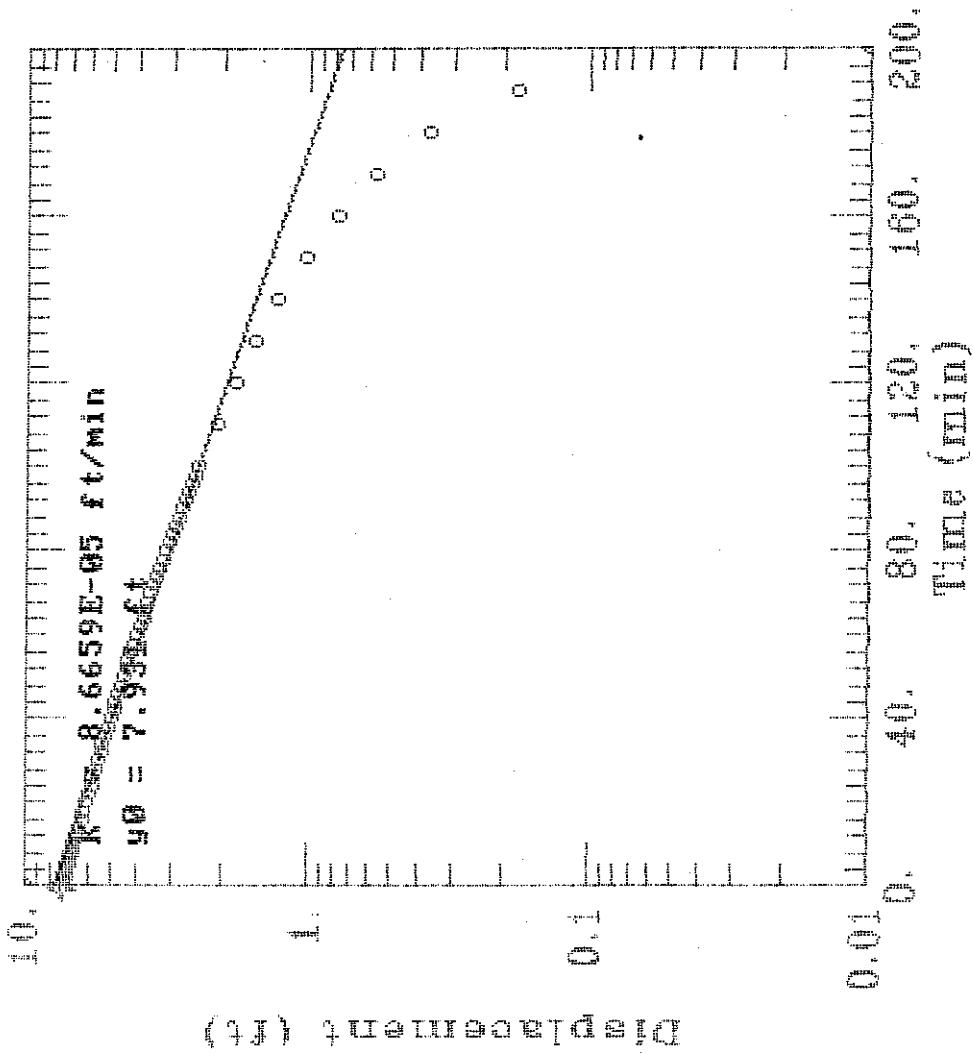
CG-28 Ball Test 1



(44) - 41694

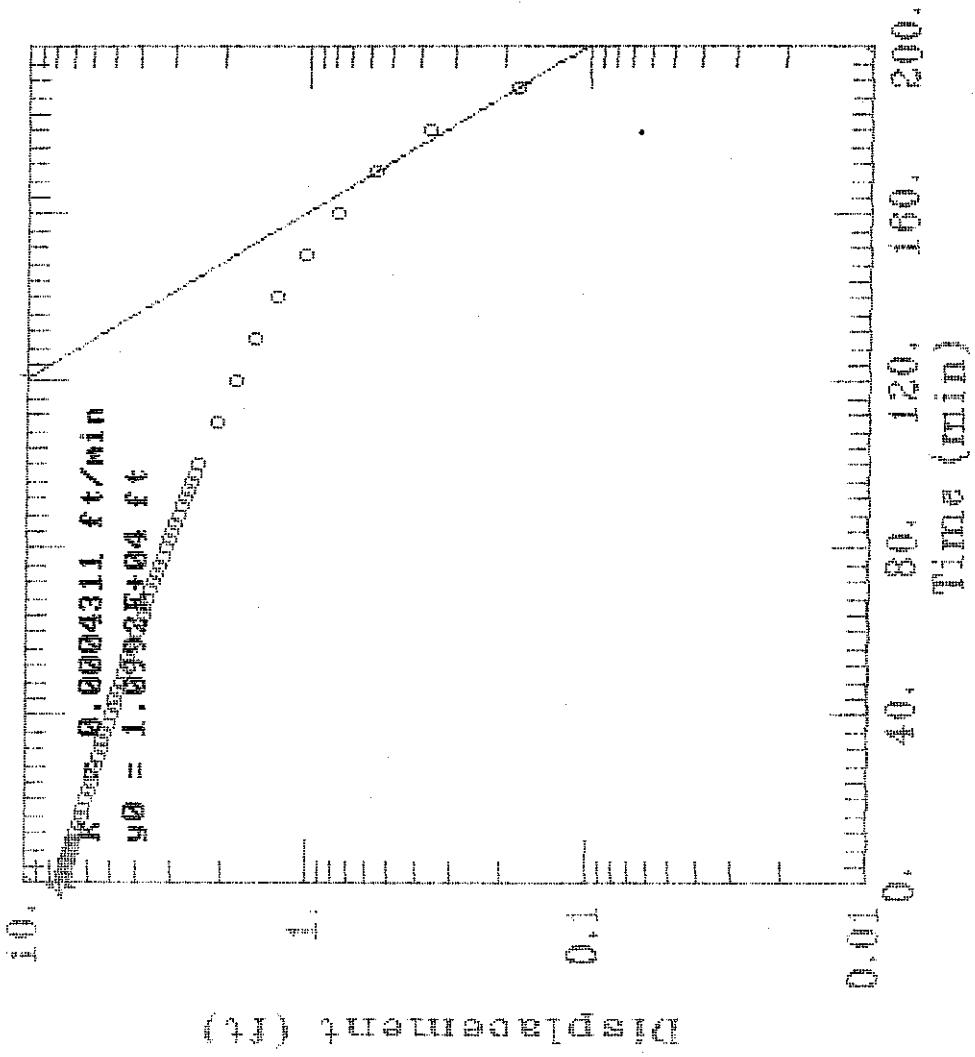
00196

CC-29 Fall Test 1



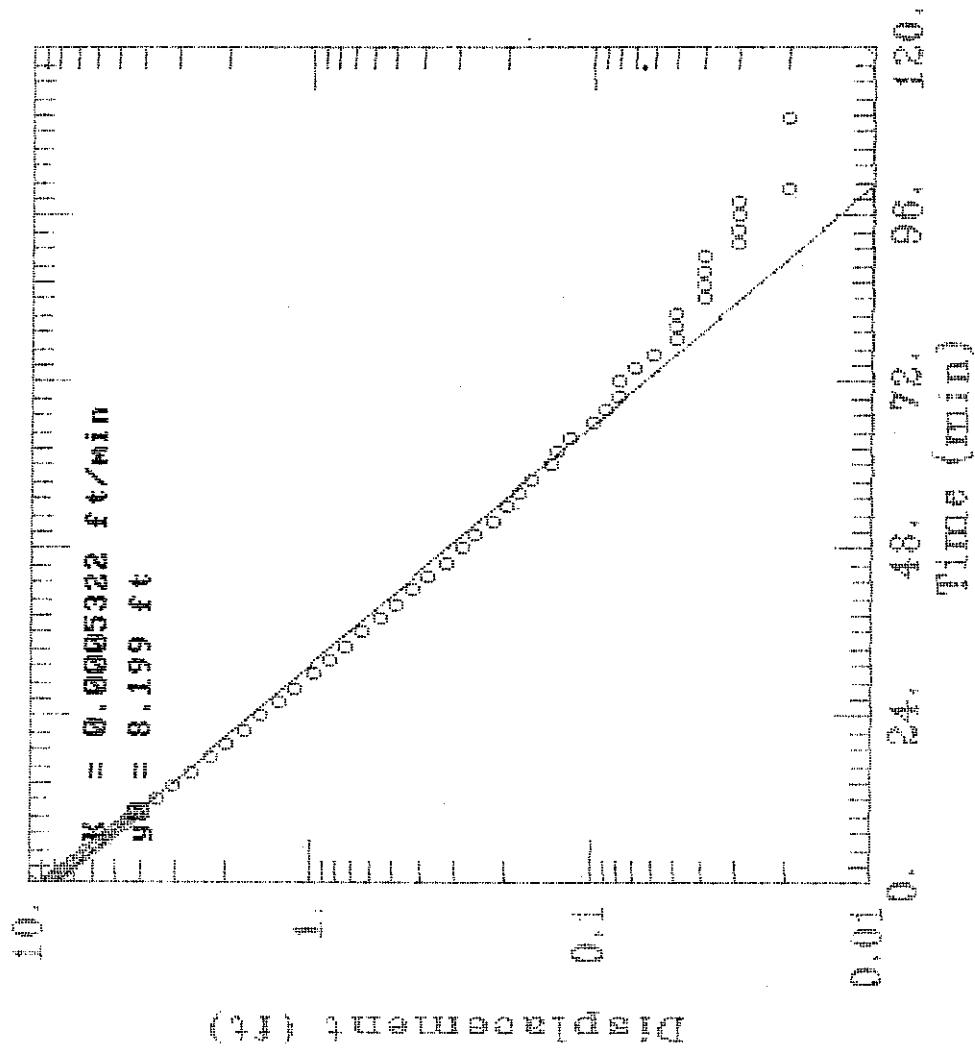
00197

CC-29 Ball Test 1



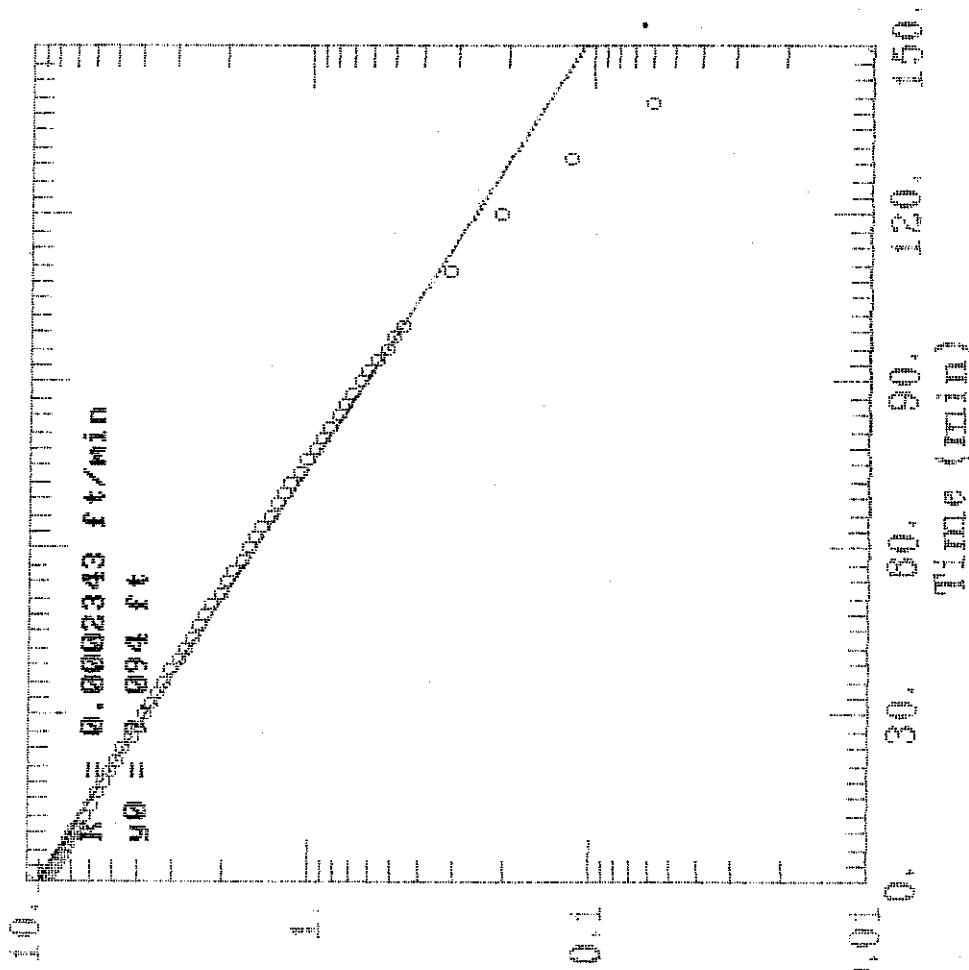
00108

CC-34 Test 1



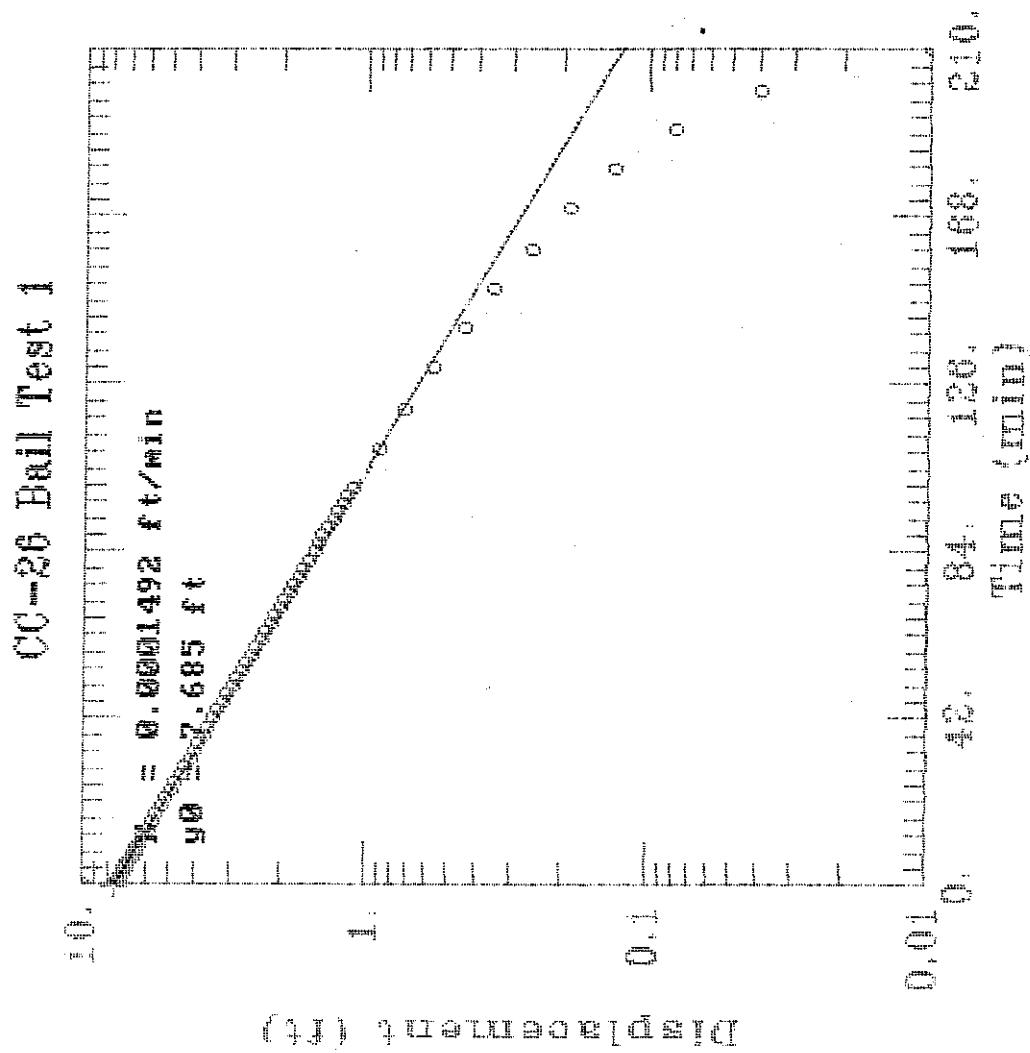
00189

CC-35 Rail Test 1



Displacement (ft)

00200



Borehole dilution tests

Borehole dilution tests were performed in the following wells: R-1, R-2, R-3, R-7, R-11, R-13, R-15, R-17, R-19, R-22, R-24, R-25, CC-6, CC-7, CC-9, CC-12, CC-13, CC-17, CC-23, CC-24, and CC-26, where the R prefix refers to Site 1 wells and the CC prefix refers to Site 2 wells.

The governing equation is given in section 1 of the dissertation. The governing equation is integrated and solved for q:

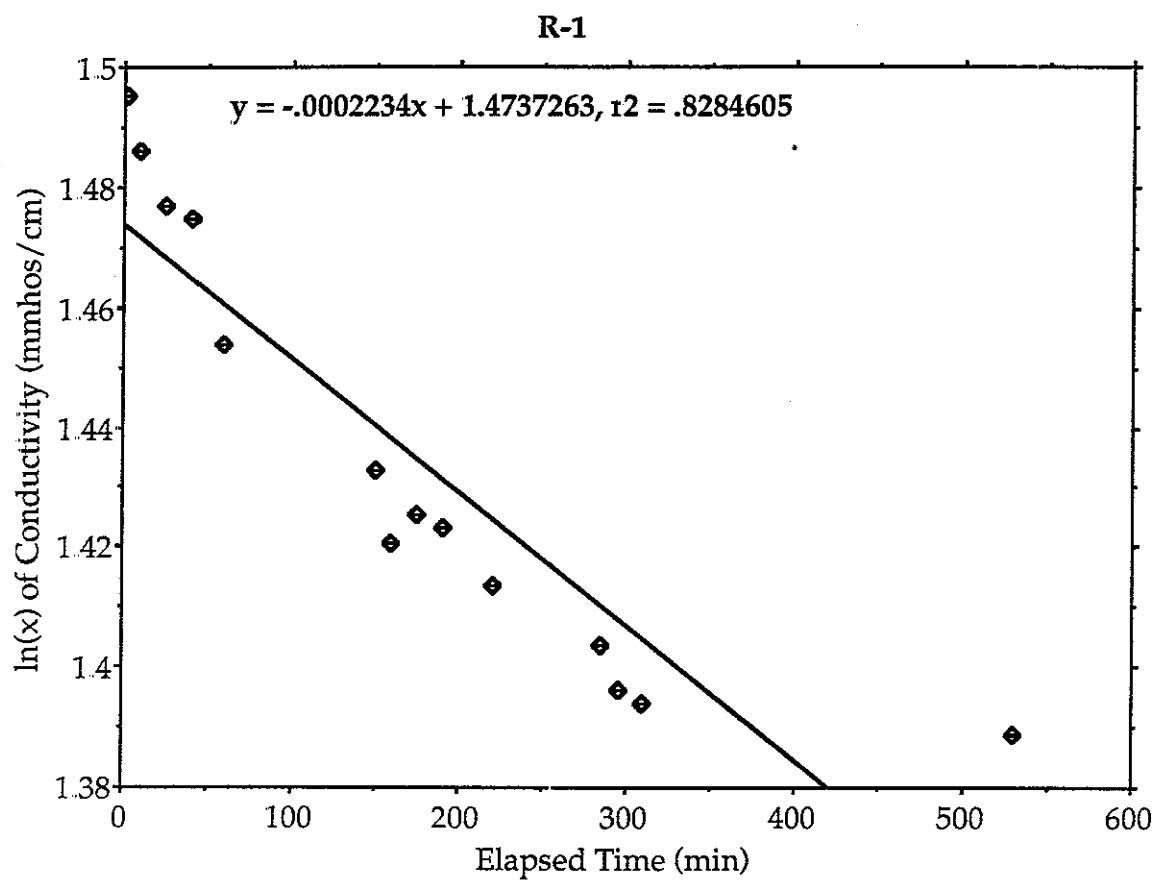
$$q = -\frac{W}{At} \ln\left(\frac{C_t - C_i}{C_o - C_i}\right)$$

This equation can be written as:

$$q = -\frac{W}{A} (\text{slope})$$

The terms W and A are constants, and represent the mixing volume of the tracer and the cross sectional area of the test section, respectively. The value of W is the sum of the volume of the flow-through cell, the volume of the tested section, and the volume of the tubing. The values for these constants are 0.06294 ft³ and 0.1706 ft², respectively. The quotient of W/A is 0.36893 ft. This value is multiplied by the slope of the line to give the value of q. Equation 1.3 is used to solve for the true velocity V. Values of V are printed at the bottom of each graph in units of ft/day and cm/day.

00202



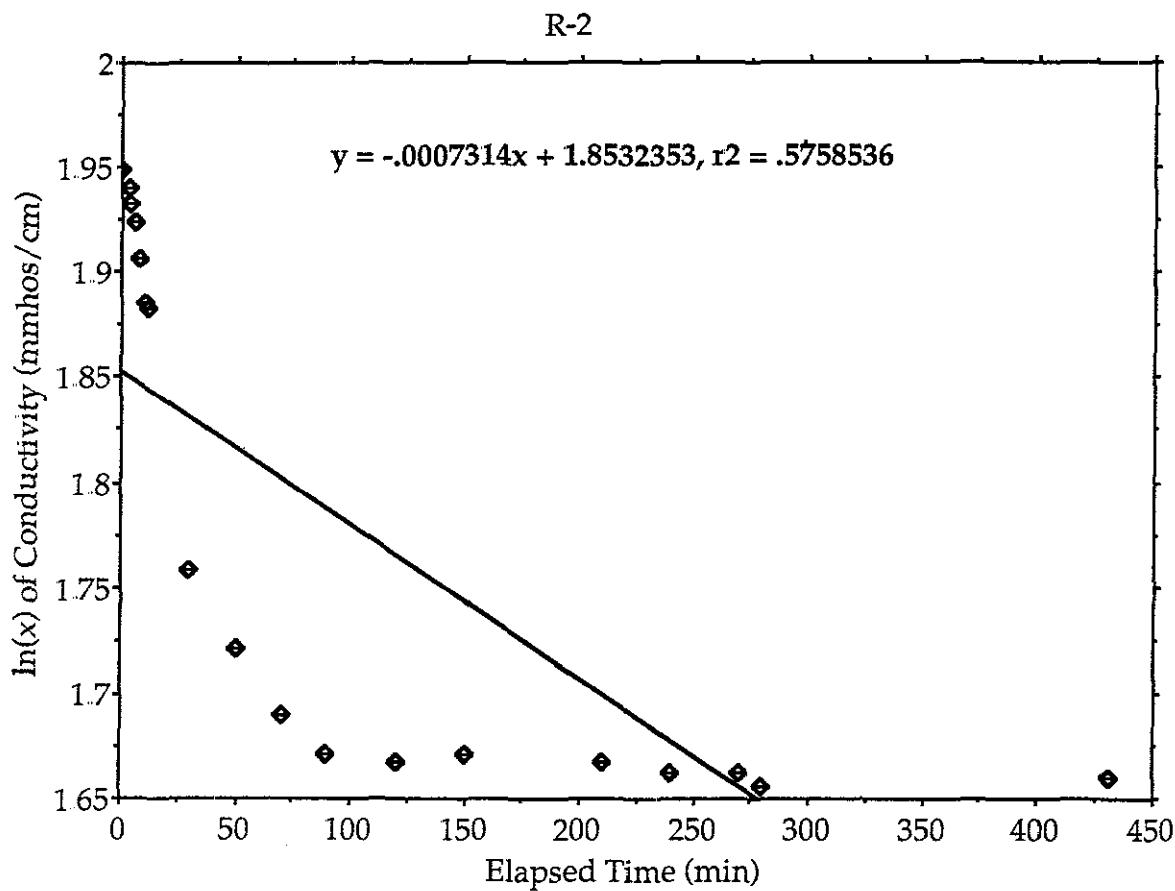
$$V' = 8.24 \times 10^{-5}$$

$$V = 3.58 \times 10^{-4} \text{ ft/min}$$

$$= 0.52 \text{ ft/day}$$

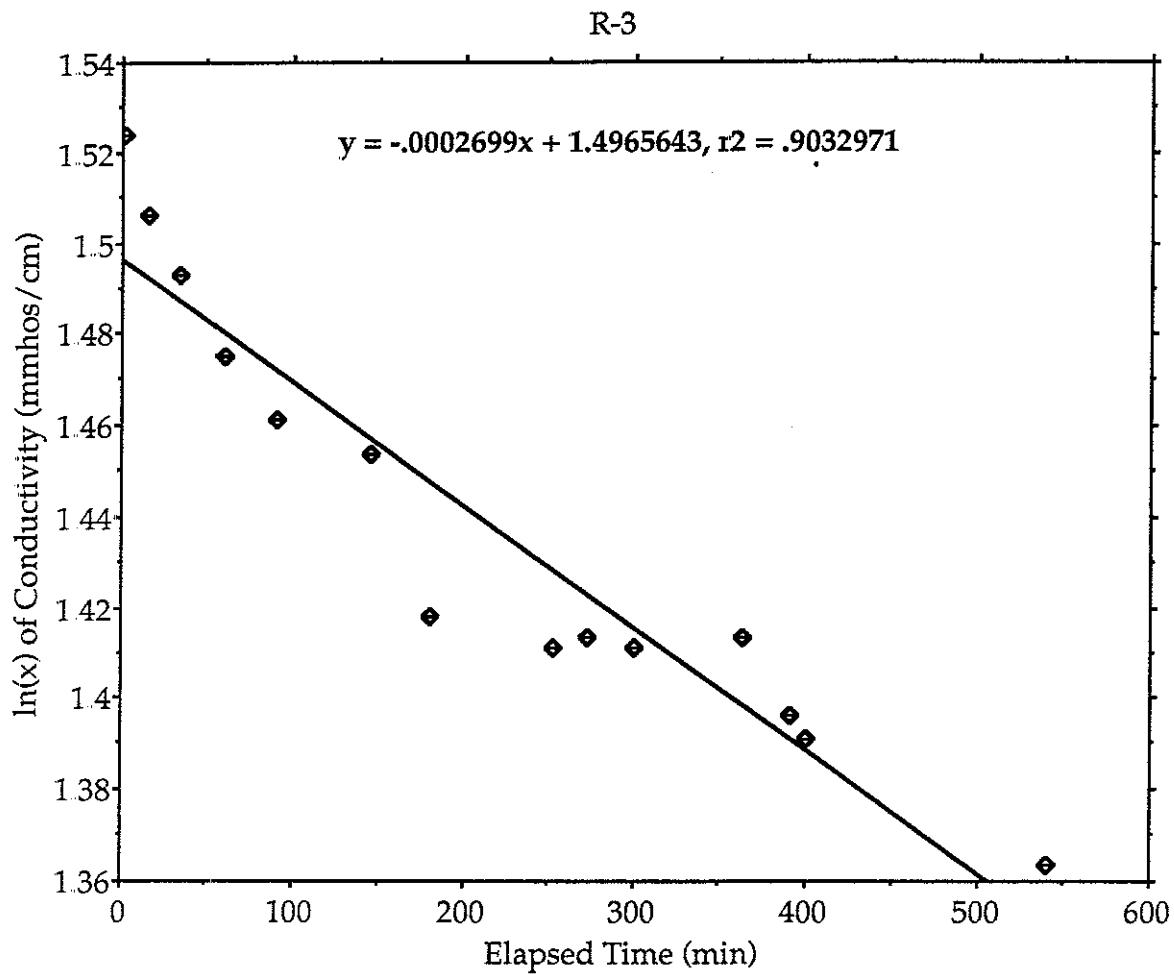
$$= 15.9$$

00203



$$\begin{aligned}V^k &= 2.7E-4 \\&= 1.17E-3 \text{ ft/min} \\&= 1.69 \text{ ft/d} \\&= 51.5 \text{ cm/d}\end{aligned}$$

00204



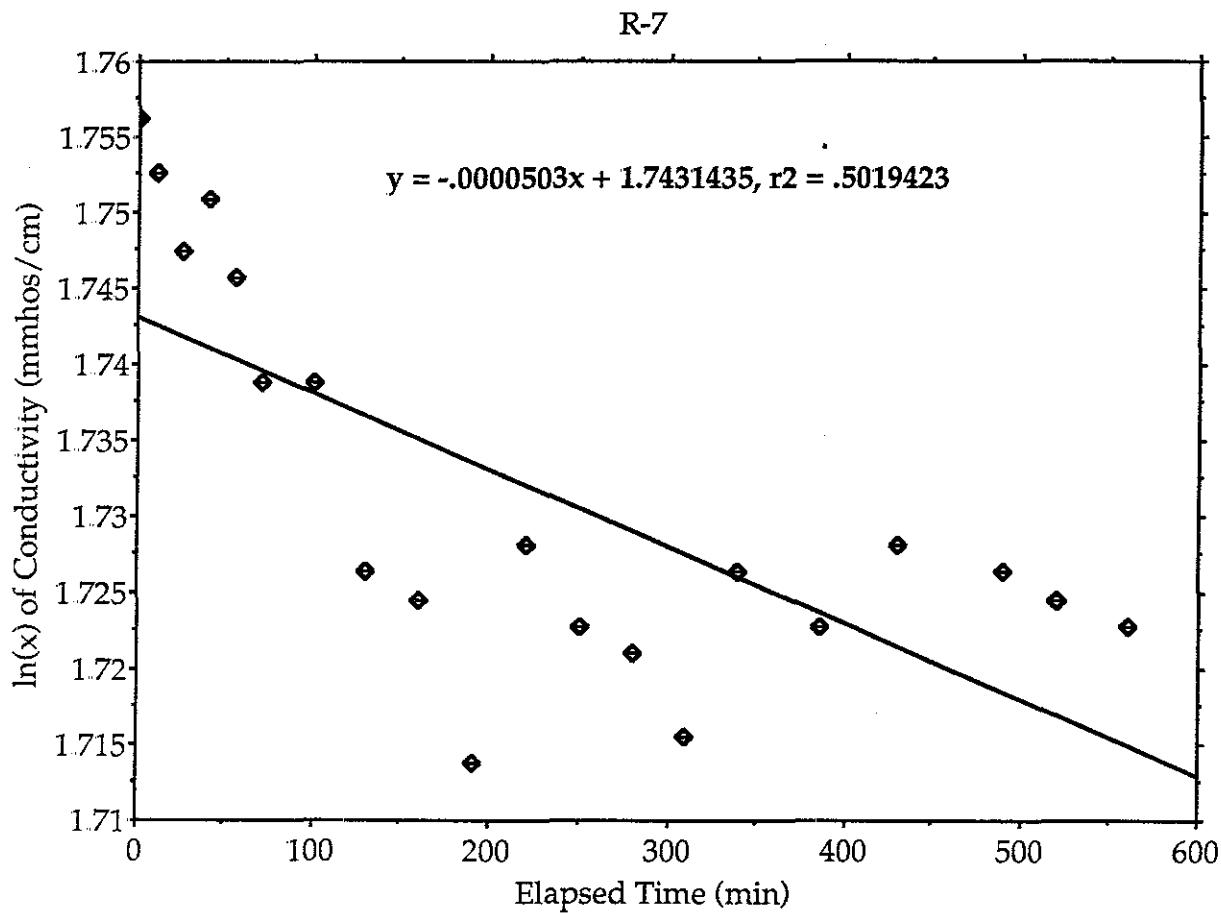
$$V^* = 9.96 \times 10^{-5}$$

$$V = 4.33 \times 10^{-4}$$

$$= .62 \text{ ft/d}$$

$$= 18.9 \text{ cm/d}$$

00205



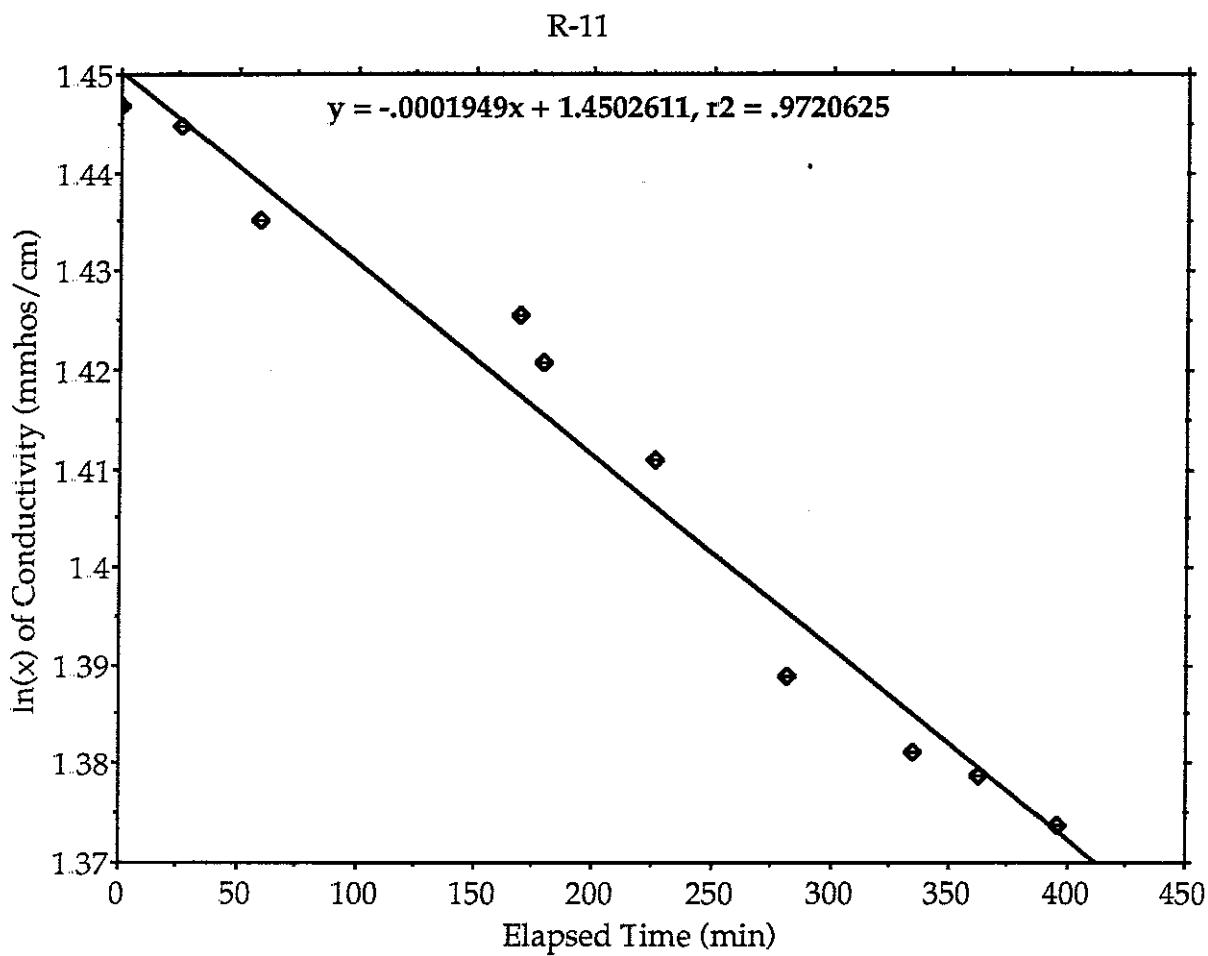
$$V^* = 1.86 \times 10^{-5}$$

$$V = 8.07 \times 10^{-5}$$

$$= .12 \text{ ft/day}$$

$$= 3.7 \text{ cm/d}$$

00206



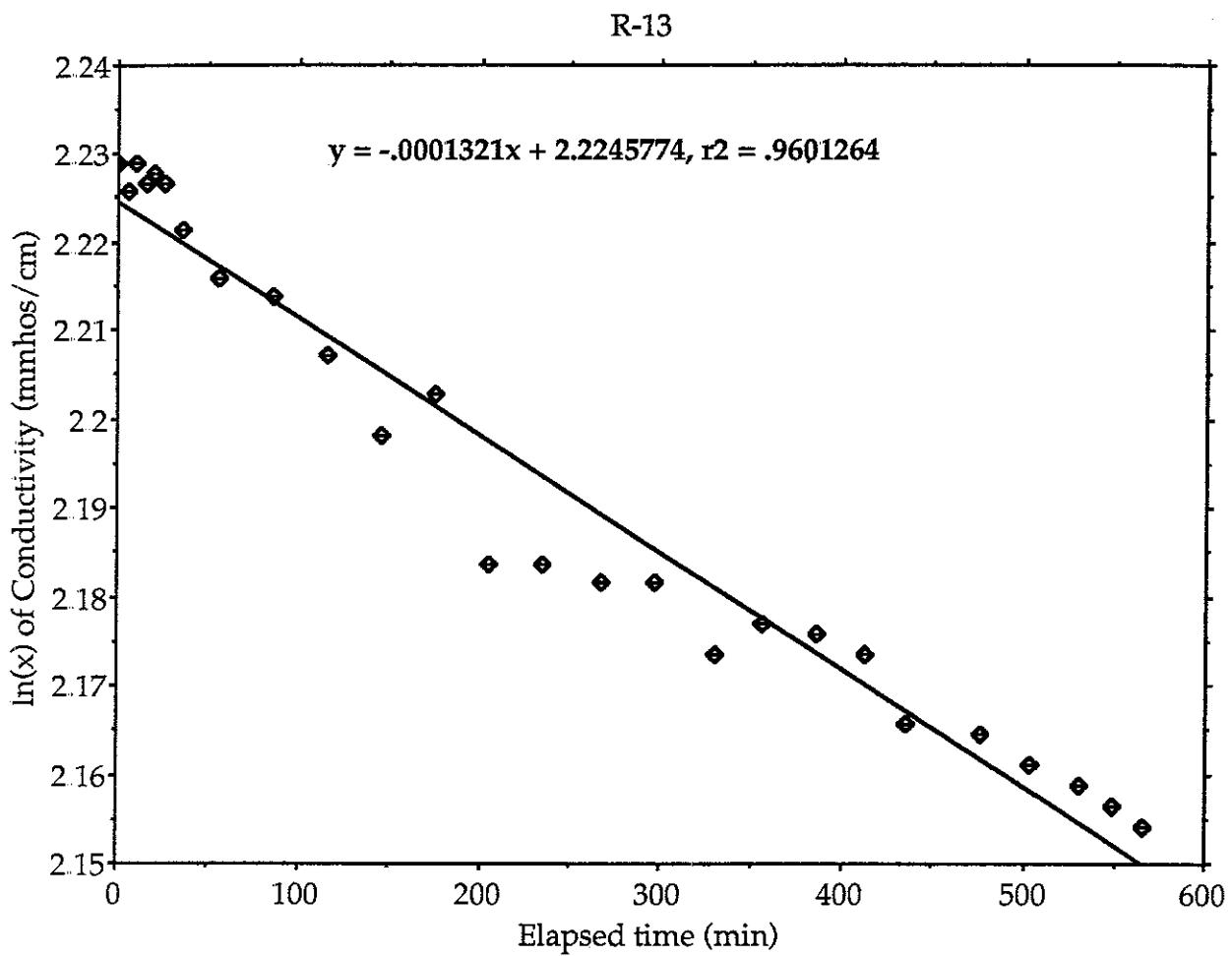
$$V^* = 7.19 \times 10^{-5}$$

$$V = 3.13 \times 10^{-4}$$

$$= .45 \text{ ft/day}$$

$$= 13.7 \text{ cm/d}$$

00207



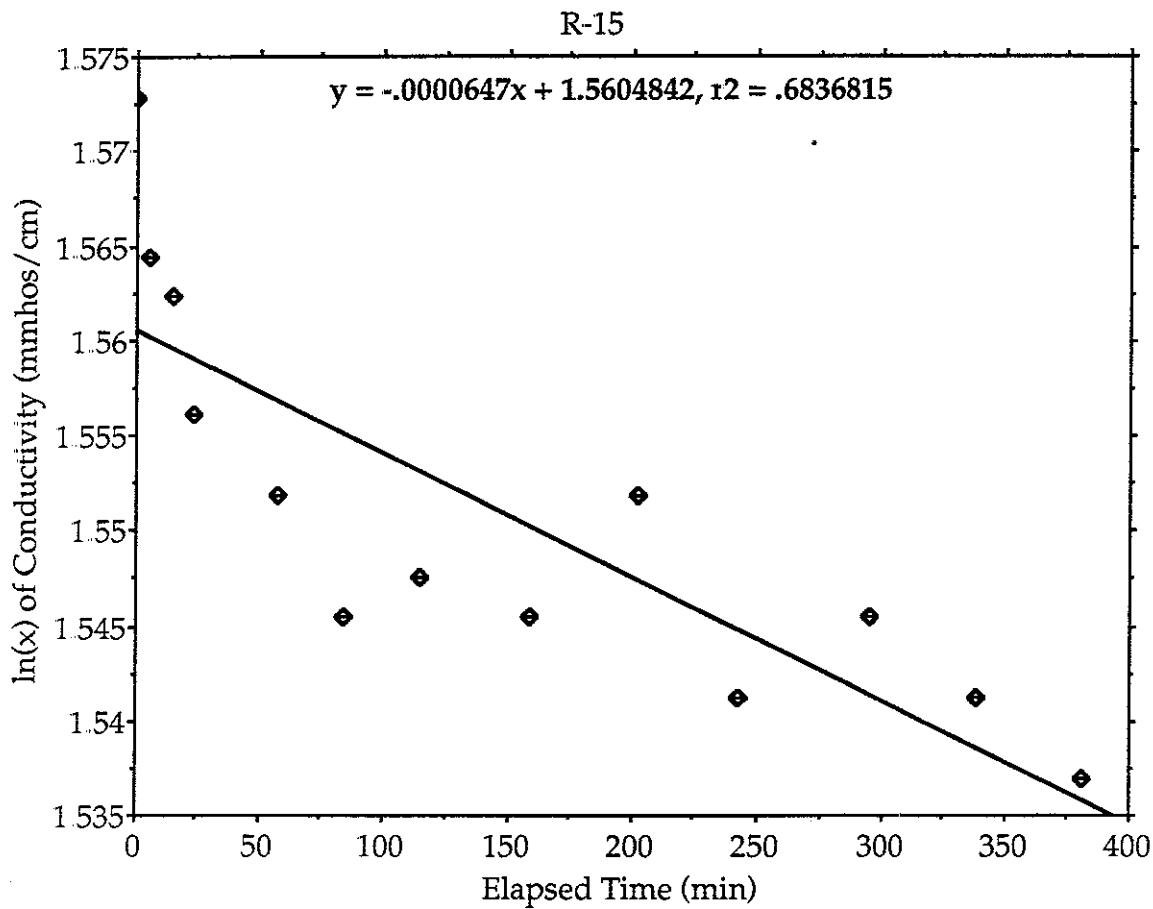
$$V^* = 4.87 \times 10^{-5} \text{ ft/min}$$

$$V = 2.12 \times 10^{-4} \text{ ft/min}$$

$$= 0.31 \text{ ft/day}$$

$$= 9.4 \text{ cm/d}$$

00208



$$V^* = 2.89 \times 10^{-5}$$

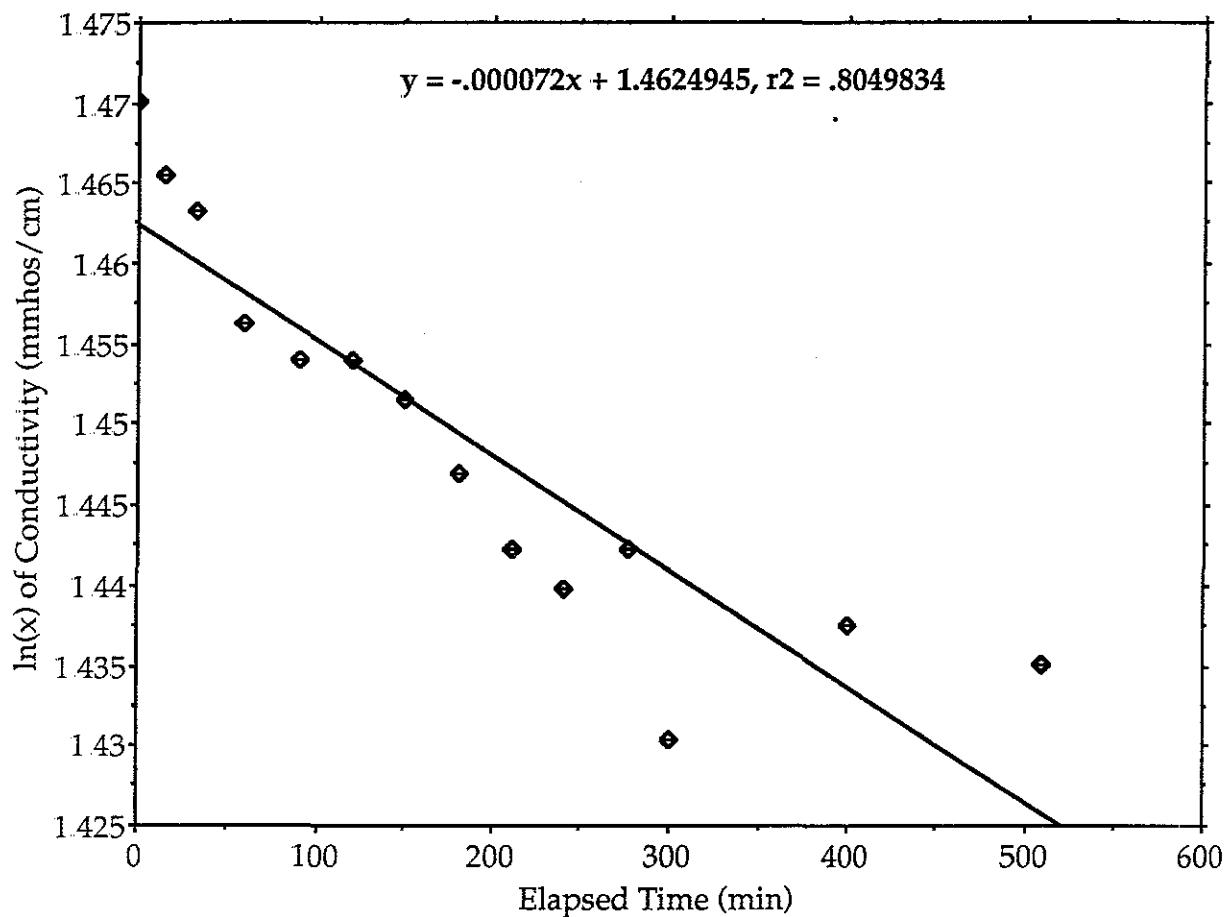
$$V = 1.04 \times 10^{-4} \text{ ft/min}$$

$$= 0.15 \text{ ft/day}$$

$$= 4.6 \text{ cm/d}$$

00209

R-17



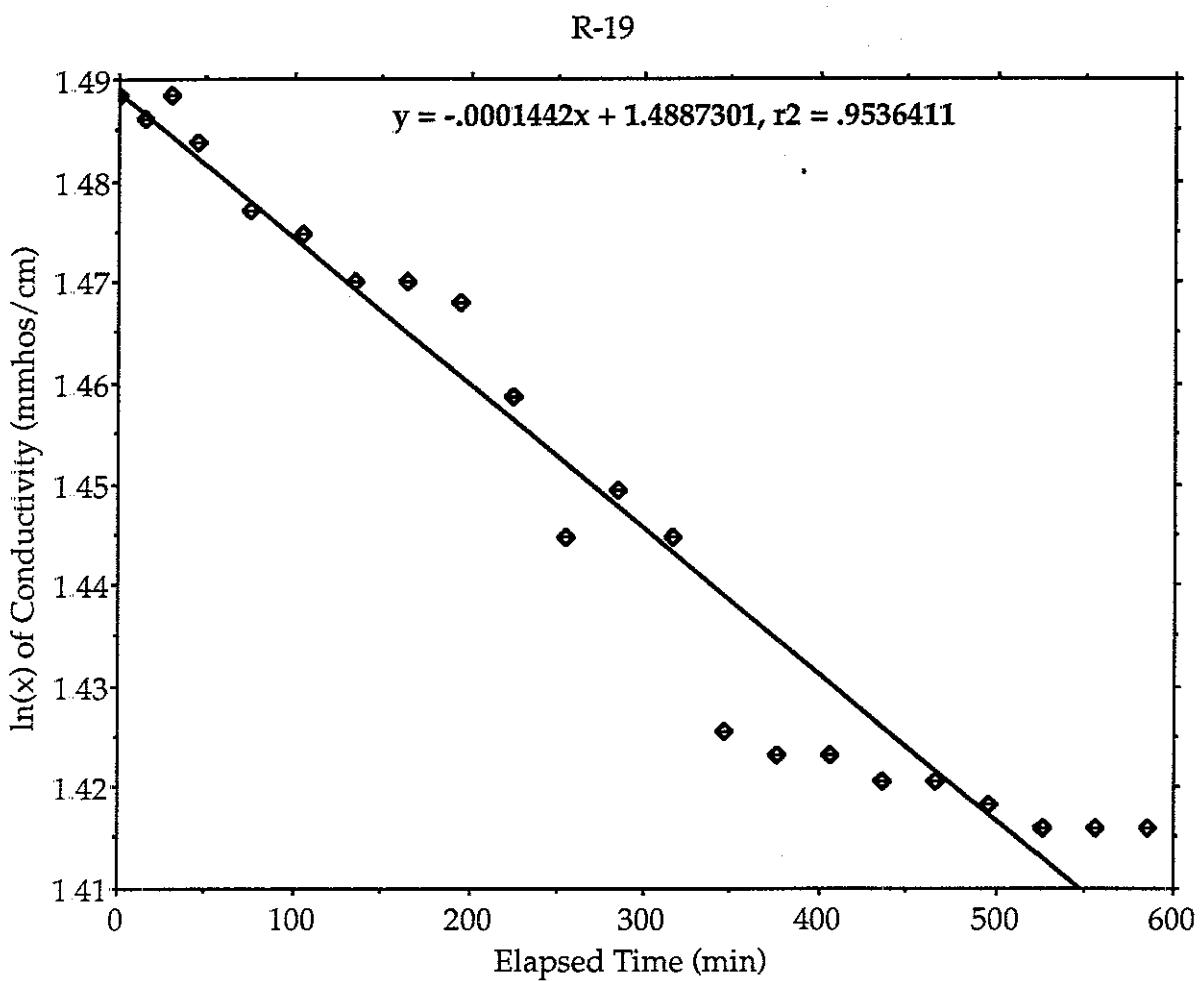
$$V^* = 2.66 \times 10^{-5}$$

$$= 1.15 \times 10^{-4} \text{ ft/min}$$

$$= 0.17 \text{ ft/day}$$

$$= 5.2 \text{ cm/d}$$

00210



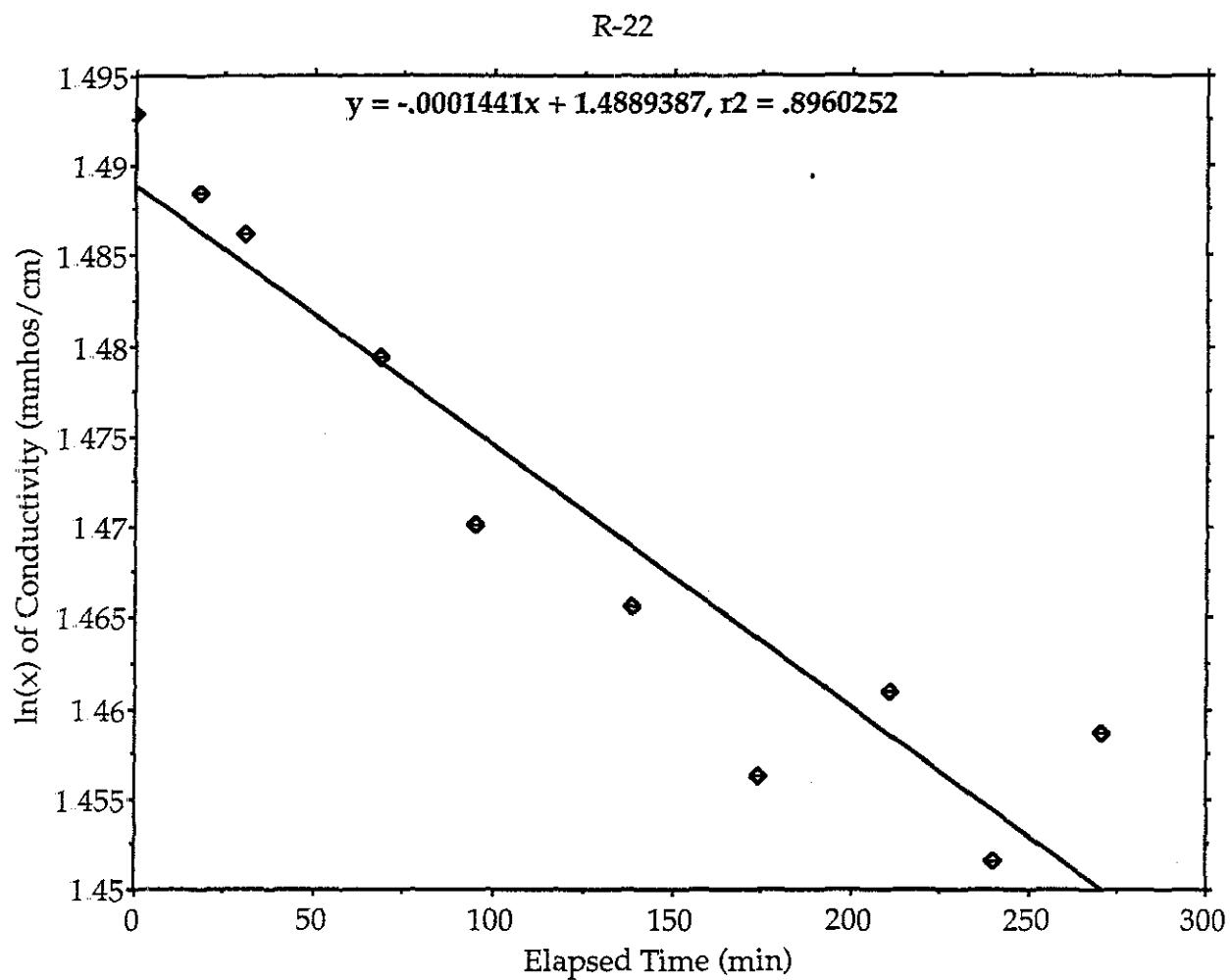
$$V^* = 5.32 \times 10^{-5}$$

$$V^* = 2.31 \times 10^{-4} \text{ ft/min}$$

$$= 0.33 \text{ ft/day}$$

$$= 10.1 \text{ cm/d}$$

00211



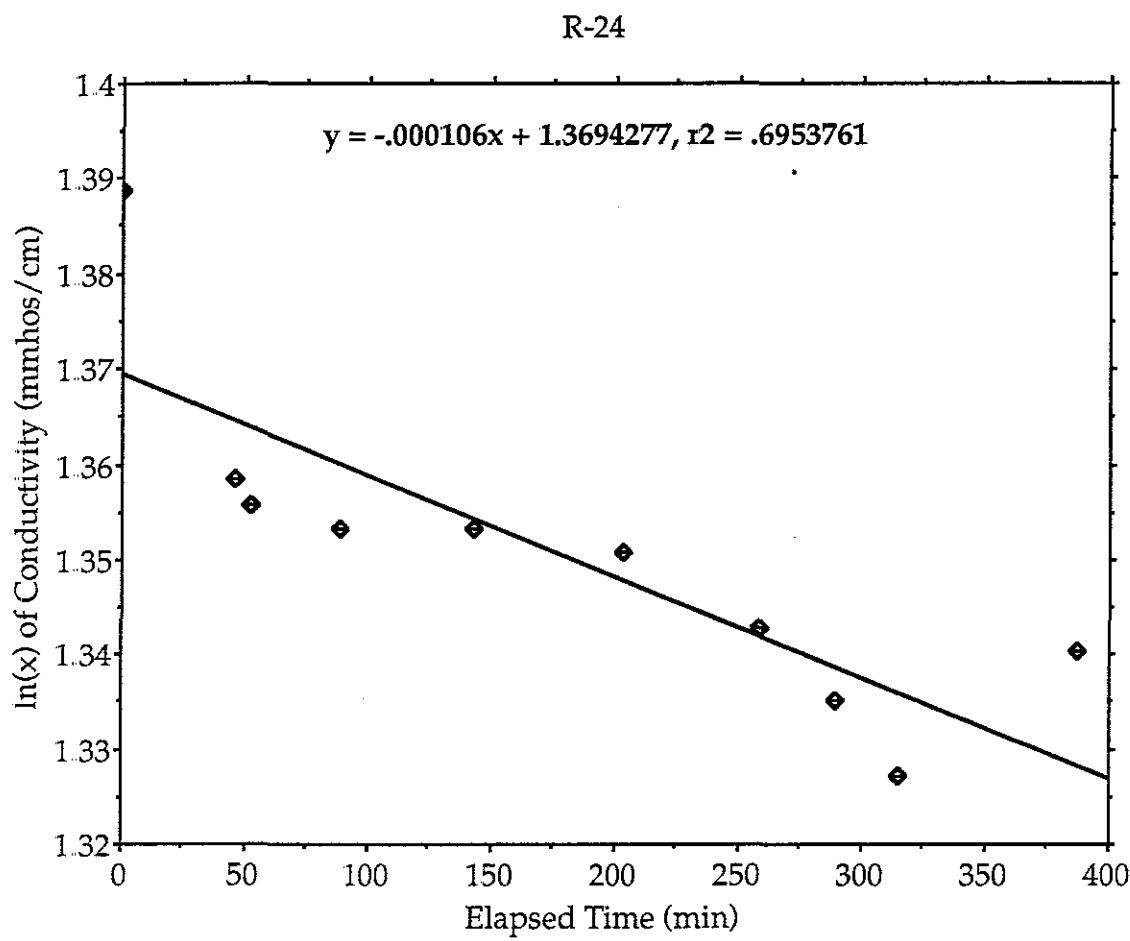
$$J^* = 5.32 \times 10^{-5} \text{ ft/min}$$

$$V = 2.31 \times 10^{-4} \text{ ft/min}$$

$$= 0.33 \text{ ft/day}$$

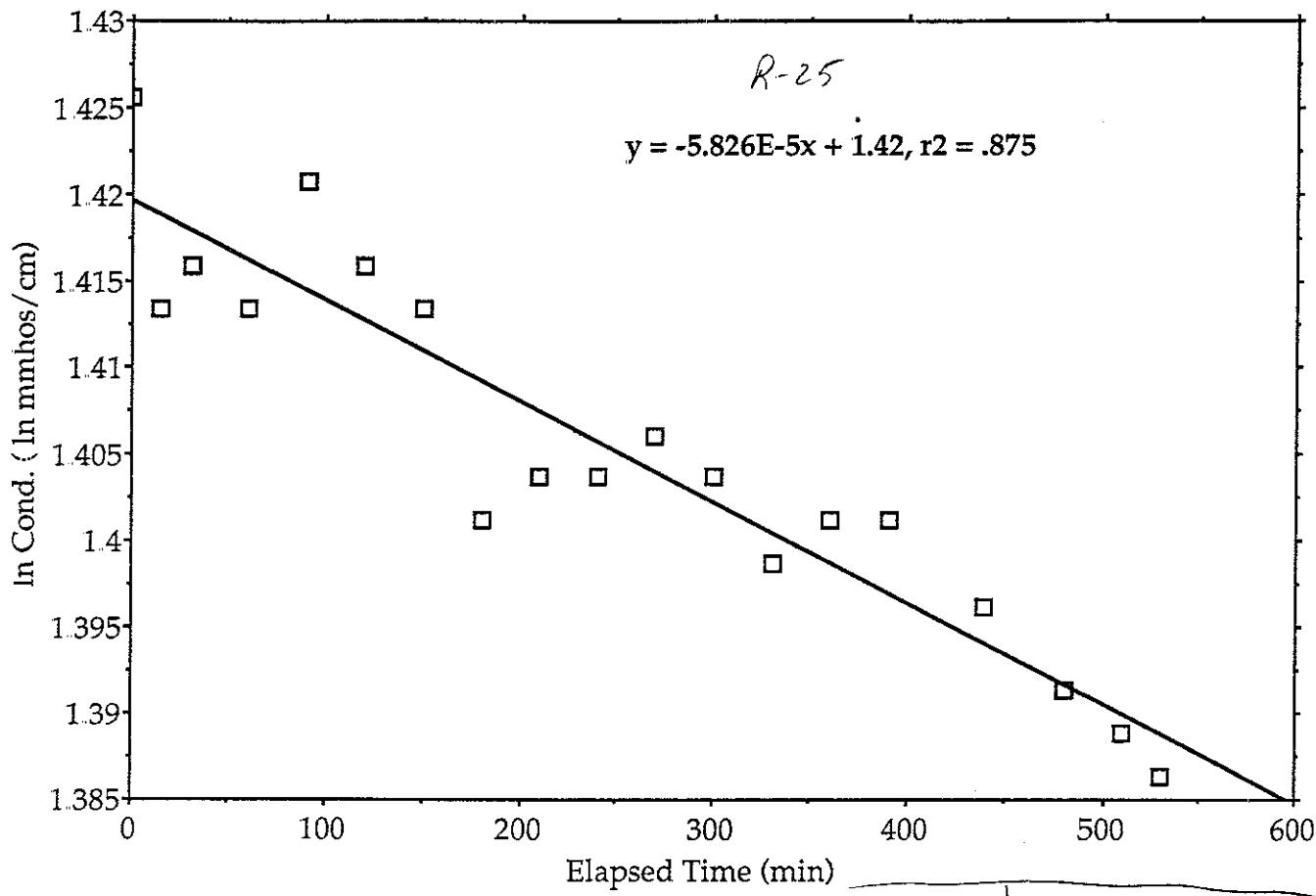
$$= 10.1 \text{ cm/d}$$

00212



$$\begin{aligned}V^2 &= 3.91 \times 10^{-5} \\&= 1.70 \times 10^{-4} \text{ ft/min} \\&= 0.24 \text{ ft/min} \\&= 7.3 \text{ cm/d}\end{aligned}$$

00213



$$V = 0.0577 \text{ ft}^3$$

$$A = 0.1706 \text{ ft}^2$$

$$\bar{V}^* = -\frac{V}{A} \text{ (slope)}$$

$$\bar{V}^* = 1.97 \text{ E-5} \quad (2.312 \text{ E-5})$$

$$\bar{V} = \frac{1.97 \text{ E-5}}{2.3(1)} = 8.57 \text{ E-5}$$

(corrected)

$$= 0.1(\%) \text{ ft/day} \quad n_e = .1$$

$$\beta = K \frac{dh}{dt}$$

$$V = \frac{K}{n_e} \frac{dh}{dt}$$

$$\frac{n_e V}{\frac{dh}{dt}} = K$$

$$\frac{dh}{dt} = .00143$$

$$K = 7 \times 10^{-3}$$

New 4-29-92

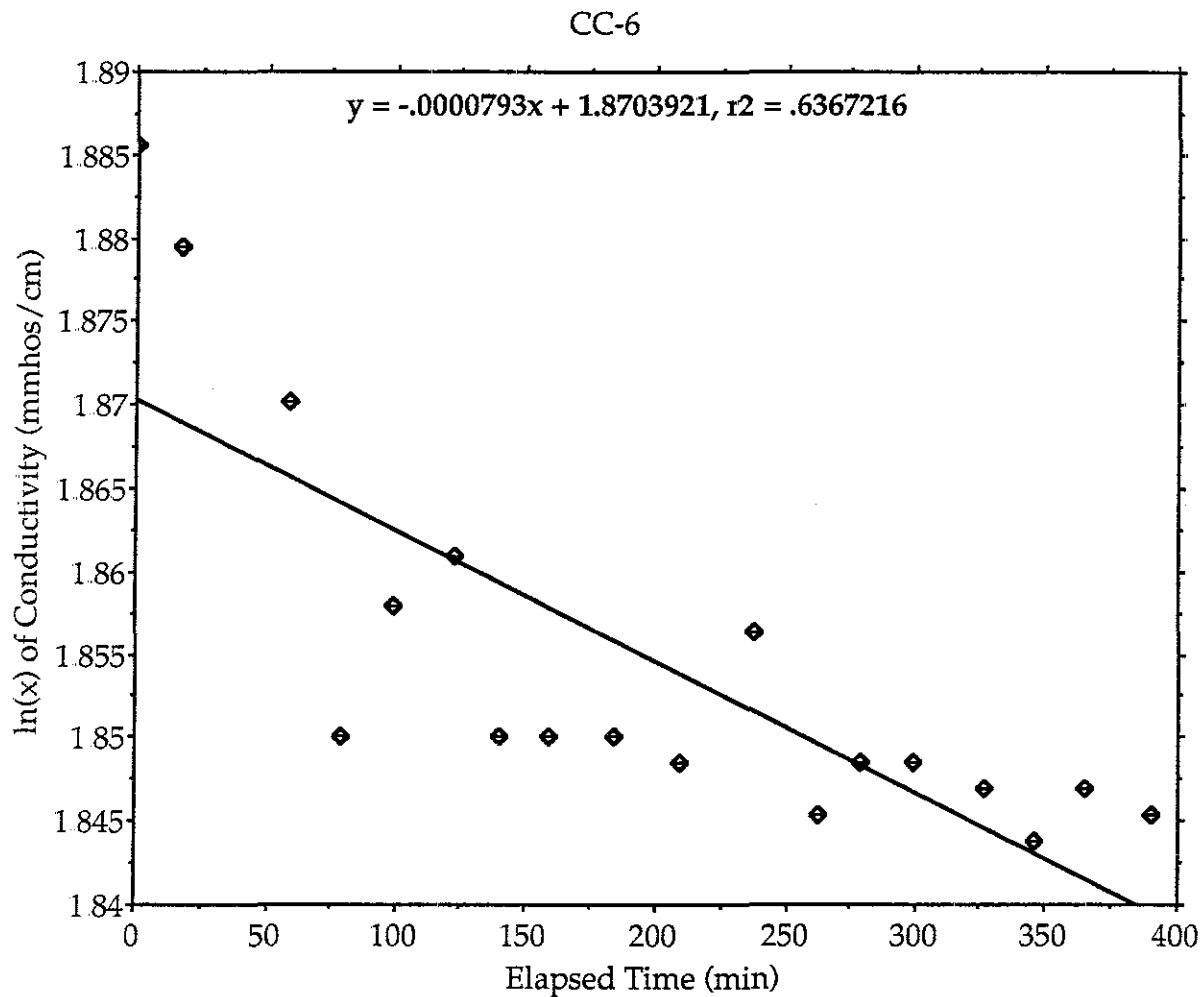
$$\bar{V}^* = 2.15 \text{ E-5}$$

$$V = 9.35 \text{ E-5 ft}^3$$

$$= 0.15 \text{ ft/day}$$

$$= 4.0 \text{ cm/d}$$

00214



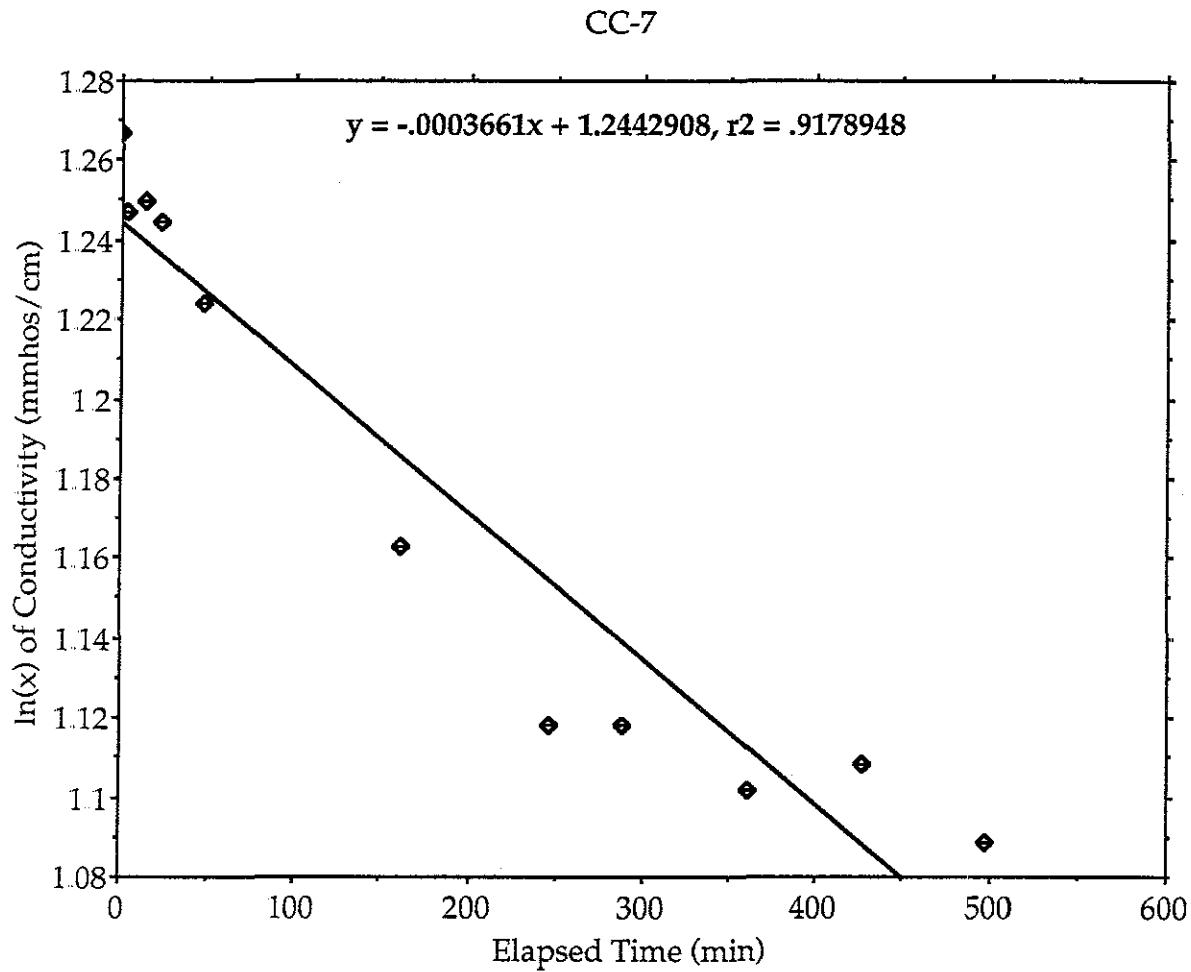
$$V^+ = 2.93 \times 10^{-5} \text{ ft/min}$$

$$V^- = 1.27 \times 10^{-4} \text{ ft/min}$$

$$= 0.18 \text{ ft/day}$$

$$= 5.5 \text{ cm/d}$$

00215



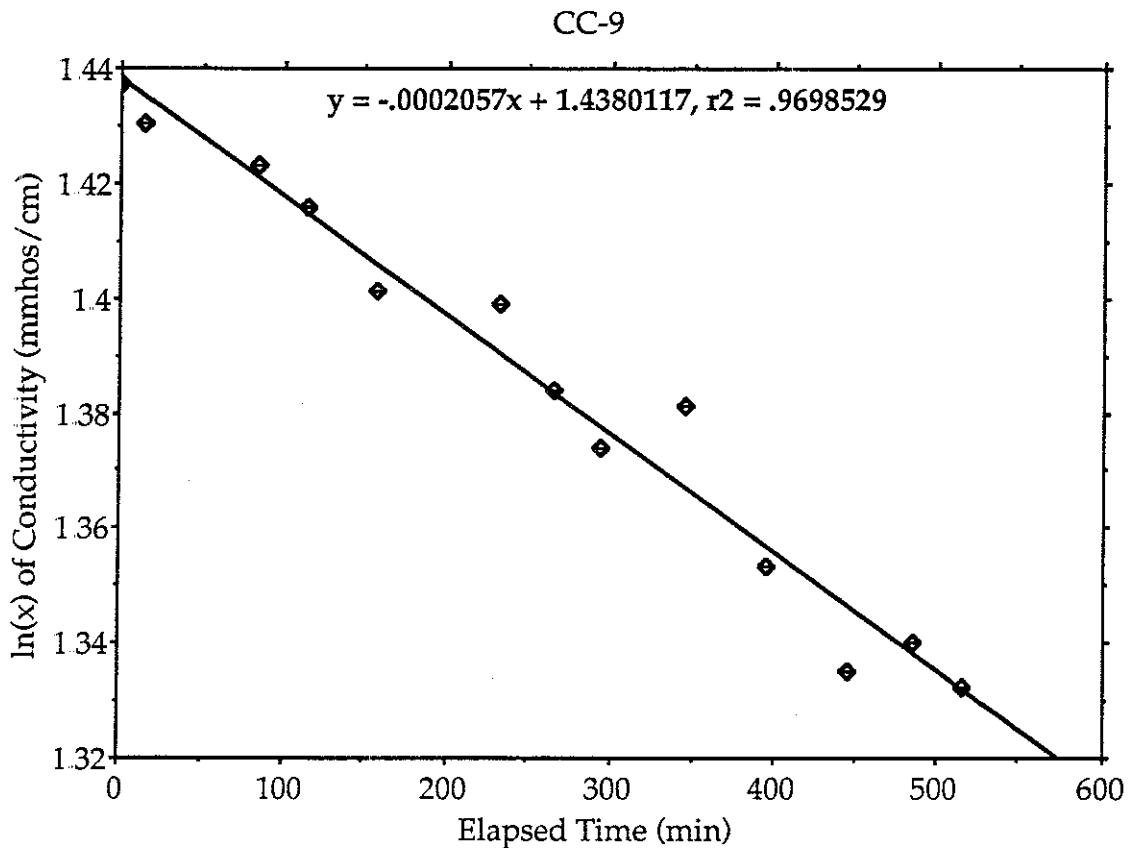
$$V^* = 1.35 \times 10^{-4} \text{ ft/min}$$

$$V = 5.87 \times 10^{-4} \text{ ft/min}$$

$$\therefore = 0.85 \text{ ft/day}$$

$$= 25.9 \text{ cm/d}$$

00216



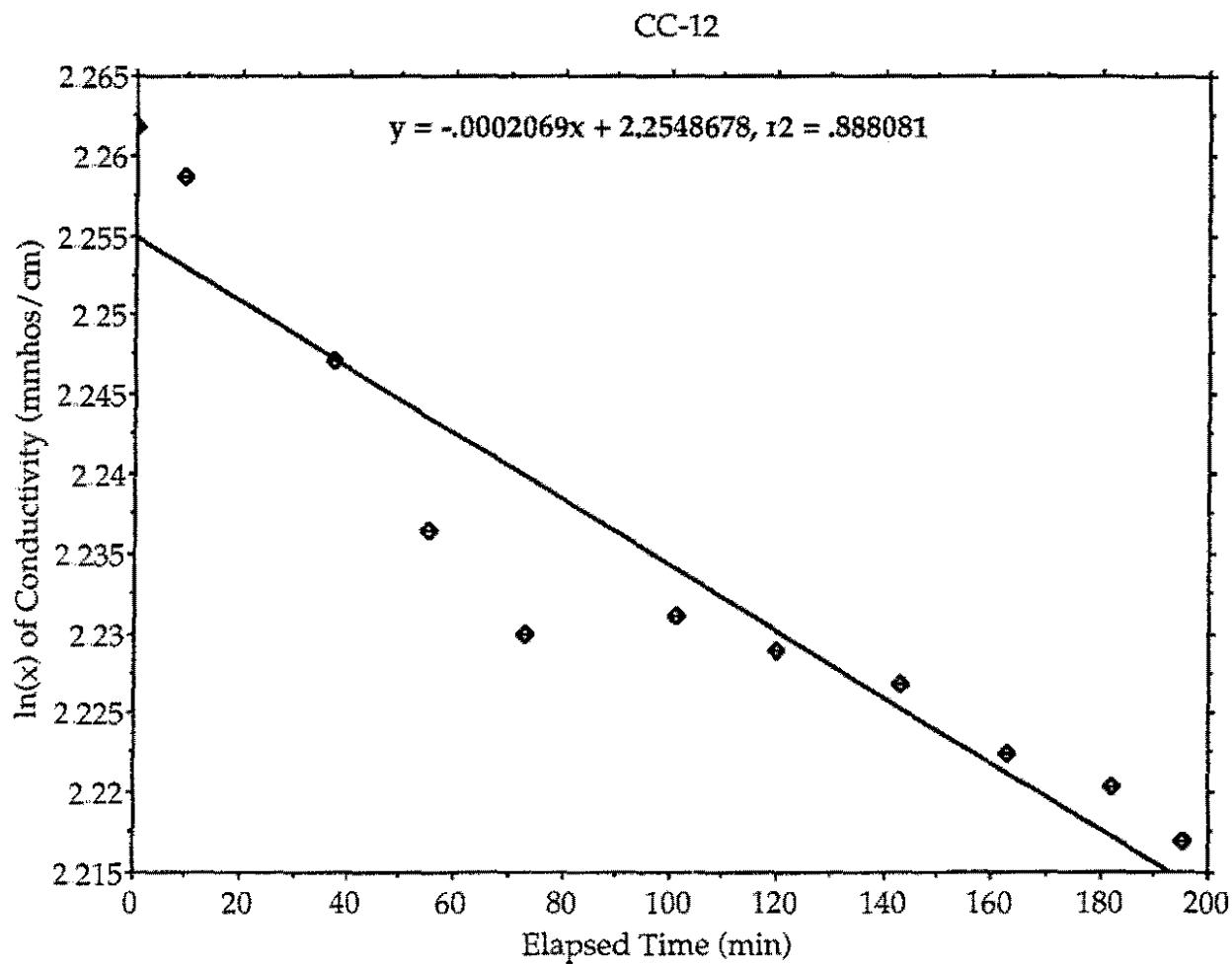
$$V^* = 7.59 \times 10^{-5}$$

$$V = 3.30 \times 10^{-4} \text{ ft/min}$$

$$= 0.48 \text{ ft/day}$$

$$= 14.6 \text{ cm/d}$$

00217



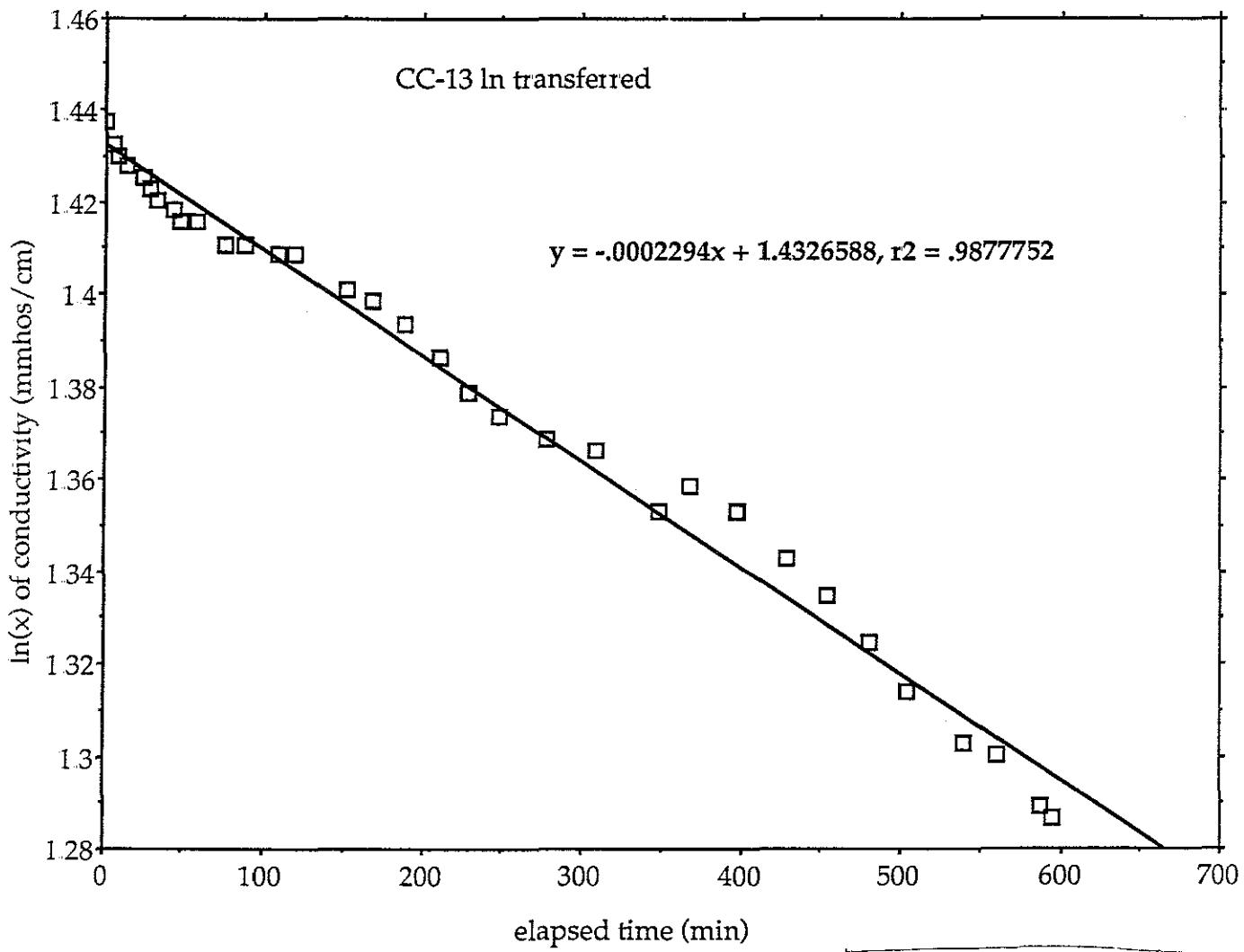
$$\sqrt{z} = 7.63 \times 10^{-5}$$

$$V = 3.32 \times 10^{-4} \text{ ft/min}$$

$$= .048 \text{ ft/day}$$

$$= 14.6 \text{ cm/d}$$

00218



$$V = .0577$$

$$\frac{.01}{.0677} \text{ ft}^3$$

$$A = 0.1706 \text{ ft}^2$$

$$\bar{V}^* = -\frac{V}{A} (\text{slope})$$

$$\bar{V}^* = 9.1 \text{ E}-5$$

$$\bar{V} = \frac{9.1 \text{ E}-5}{2.3 (-1)} = 3.96 \text{ E}-4 \text{ ft/min}$$

$$= .653 \text{ ft/day}$$

New 4-28-92

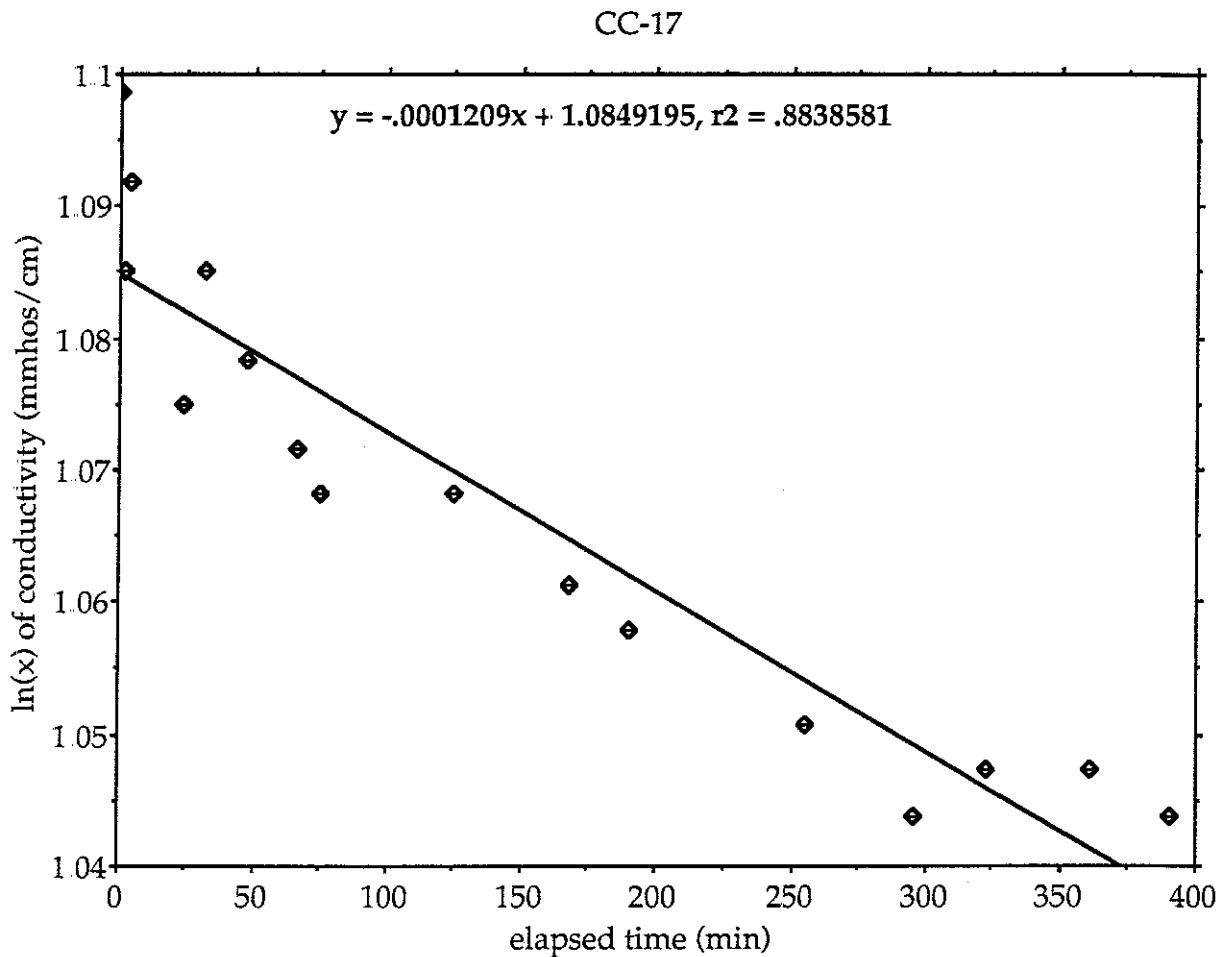
$$V^* = 8.46 \text{ E}-5$$

$$V = 3.68 \text{ E}-4 \text{ ft/min}$$

$$= 0.53 \text{ ft/day}$$

$$= 16.2 \text{ cm/d}$$

00219



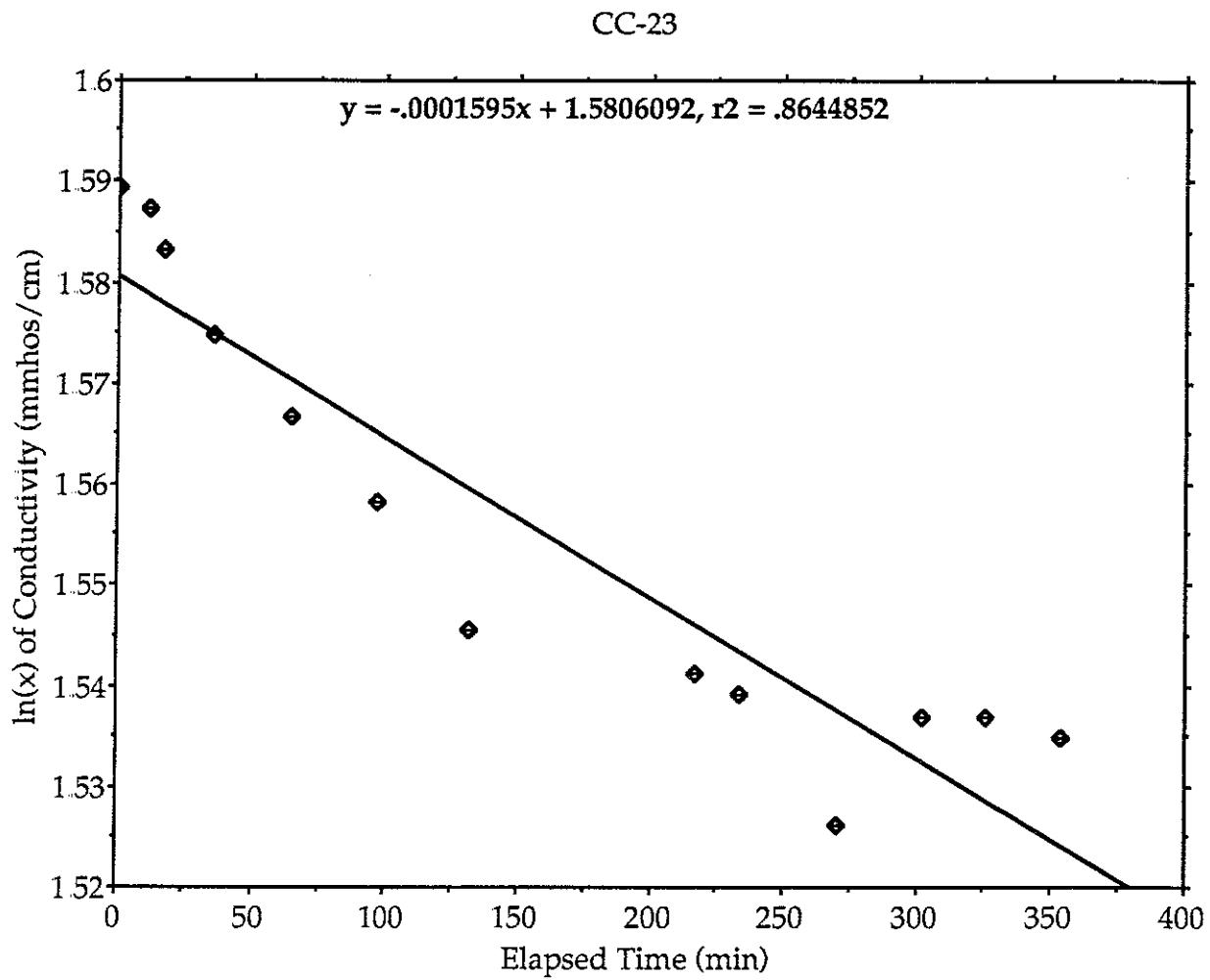
$$\sqrt{*} = 4.46 \times 10^{-5}$$

$$V = 1.94 \times 10^{-4} \text{ ft/min}$$

$$\approx 0.28 \text{ ft/day}$$

$$\approx 8.5 \text{ cm/d}$$

00220



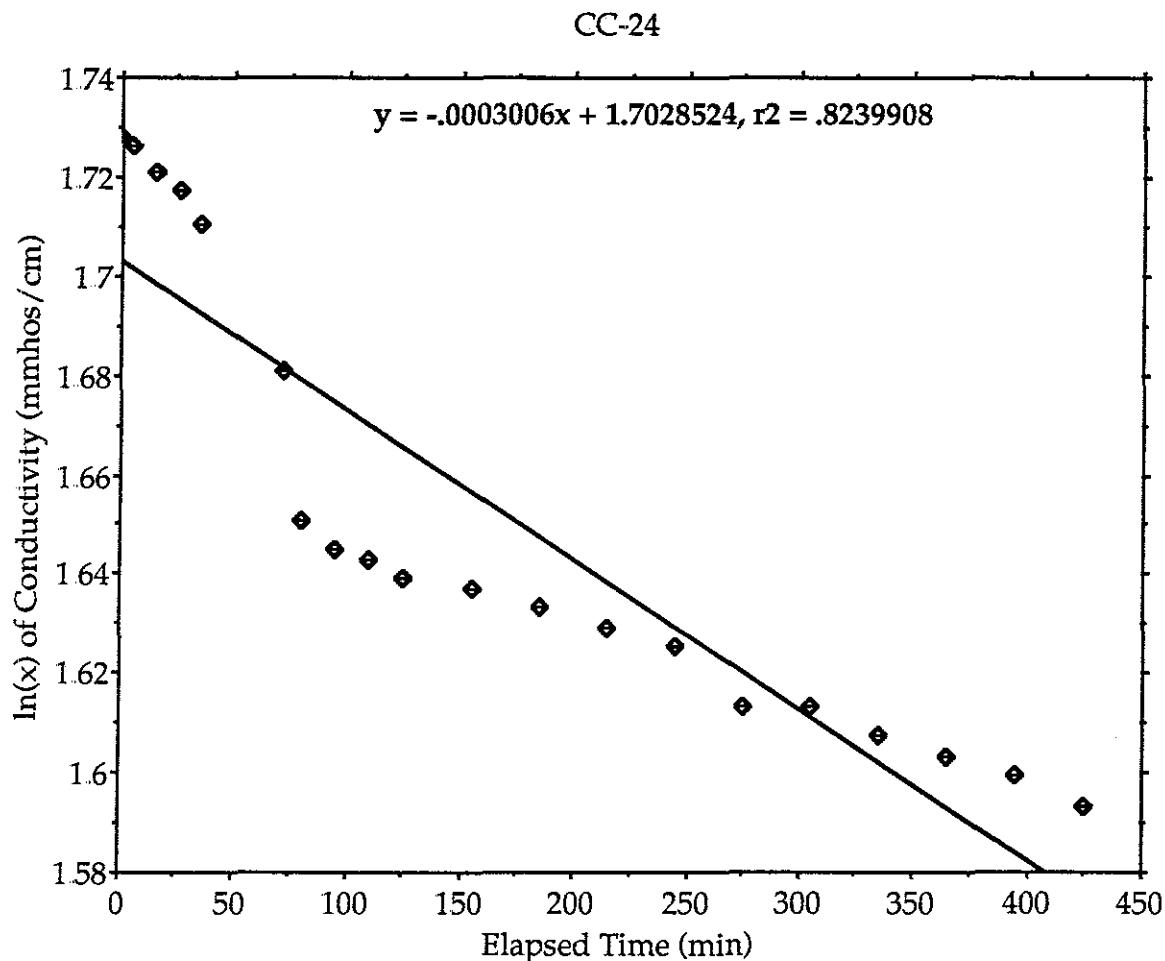
$$\sqrt{k} = 5.88 \times 10^{-5} \text{ ft/min}$$

$$= 2.56 \times 10^{-4} \text{ ft/min}$$

$$= 0.37 \text{ ft/day}$$

$$= 11.3 \text{ cm/d}$$

00221



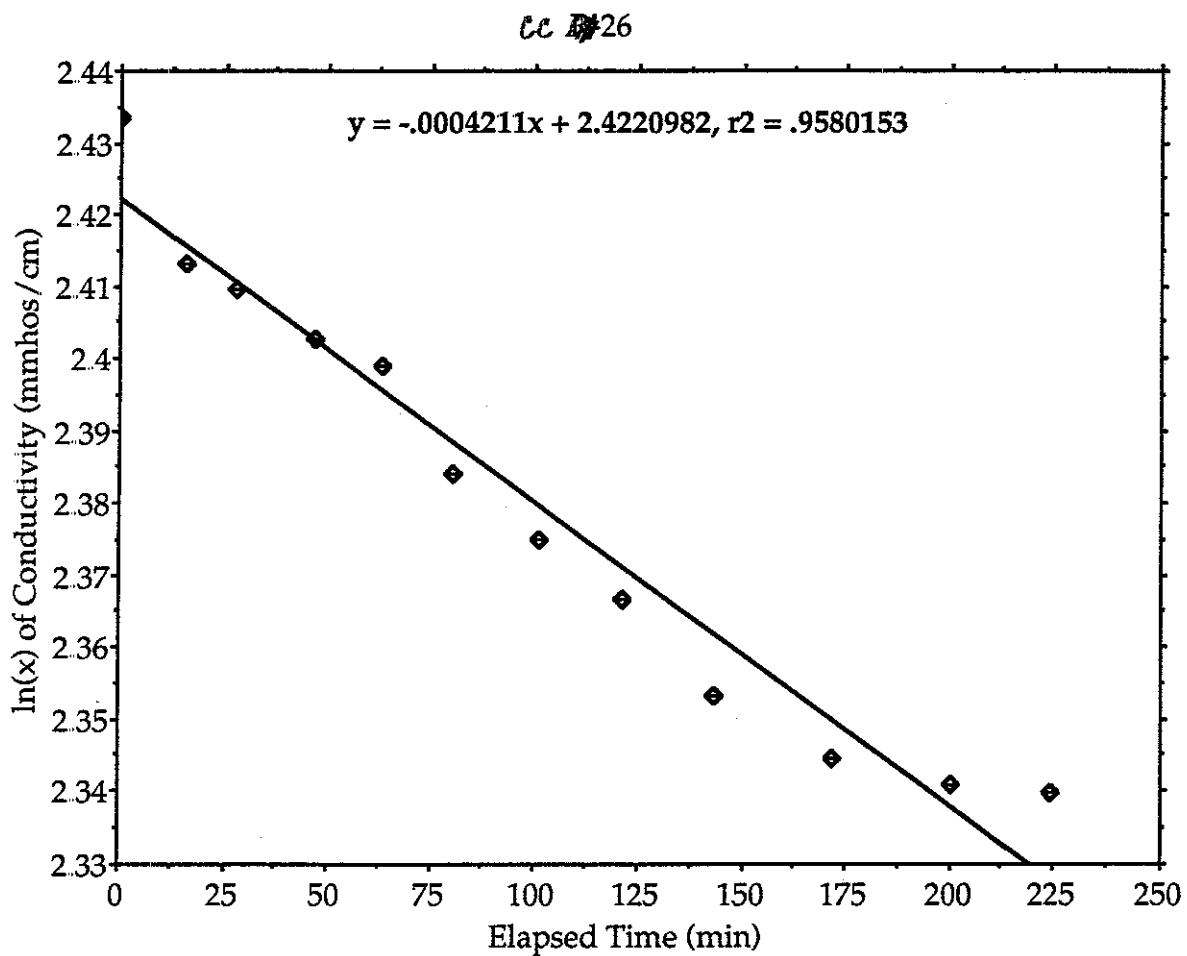
$$V^* = 1.11 \times 10^{-4}$$

$$V = 4.82 \times 10^{-4} \text{ ft/min}$$

$$\therefore = 0.69 \text{ ft/day}$$

$$= 21.0 \text{ cm/d}$$

00222



$$V^* = 1.55 \times 10^{-4}$$

$$V = 6.75 \times 10^{-4} \text{ ft/min}$$

$$\therefore = 0.97 \text{ ft/day}$$

$$\approx 29.6 \text{ cm/d}$$

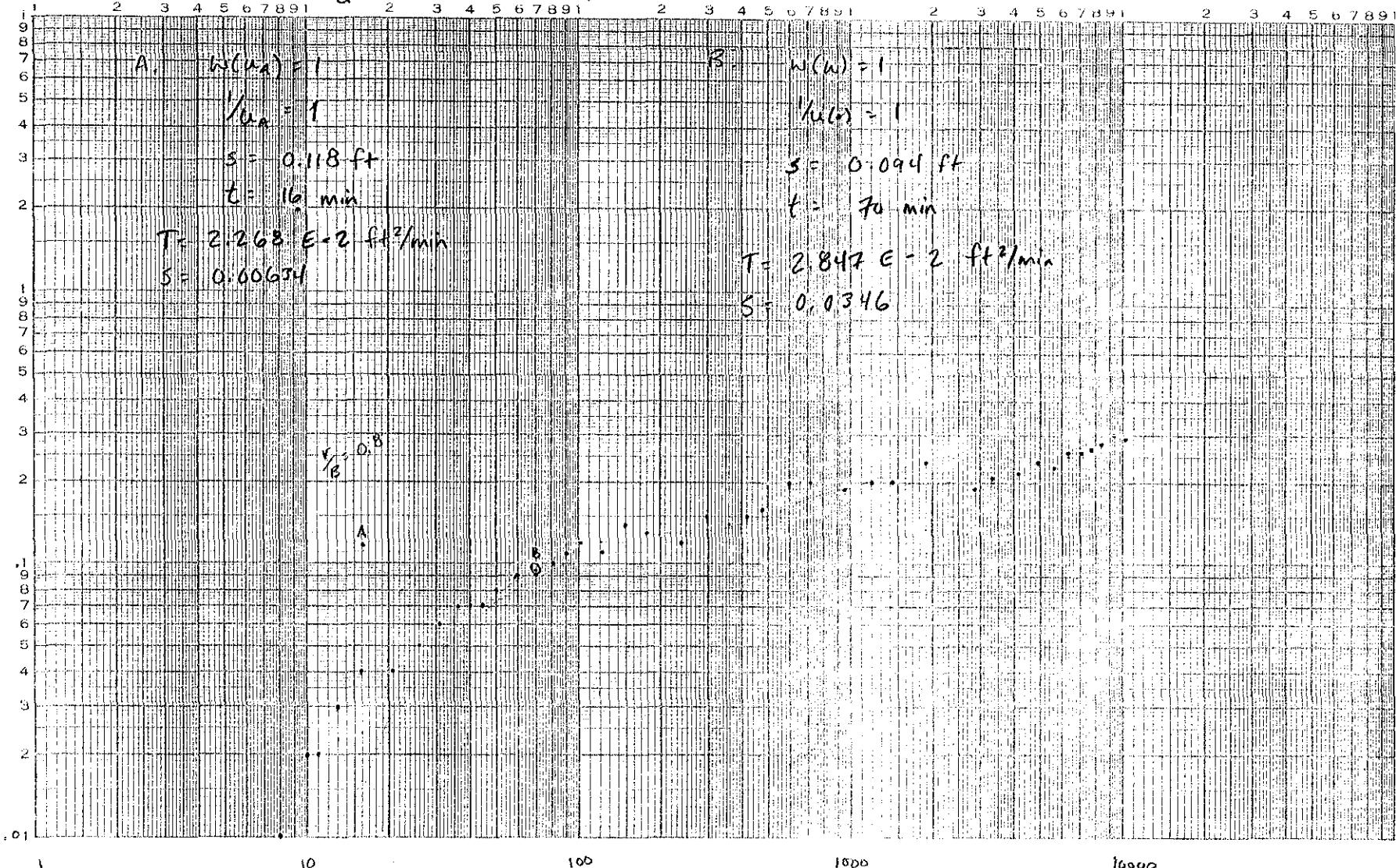
00223

Pumping tests, Boulton method - Site 1

R-1

$$r = 15.16 \text{ ft}$$

$$Q = 3,363 E^{-2} \text{ ft}^3/\text{min}$$



time (min)

00224

R-2

$$r = 10.87 \text{ ft}$$

$$Q = 3.363 E - 2 \text{ ft}^3/\text{min}$$

A. $W(u_0) = 1$

$$1/u_0 = 1$$

$$S = 0.105 \text{ ft}$$

$$t = 1.97 \text{ min}$$

$$T = 2.519 E - 2 \text{ ft}^2/\text{min}$$

$$S = 0.0017$$

$$r/B = 0.4$$

B. $W(u) = 1$

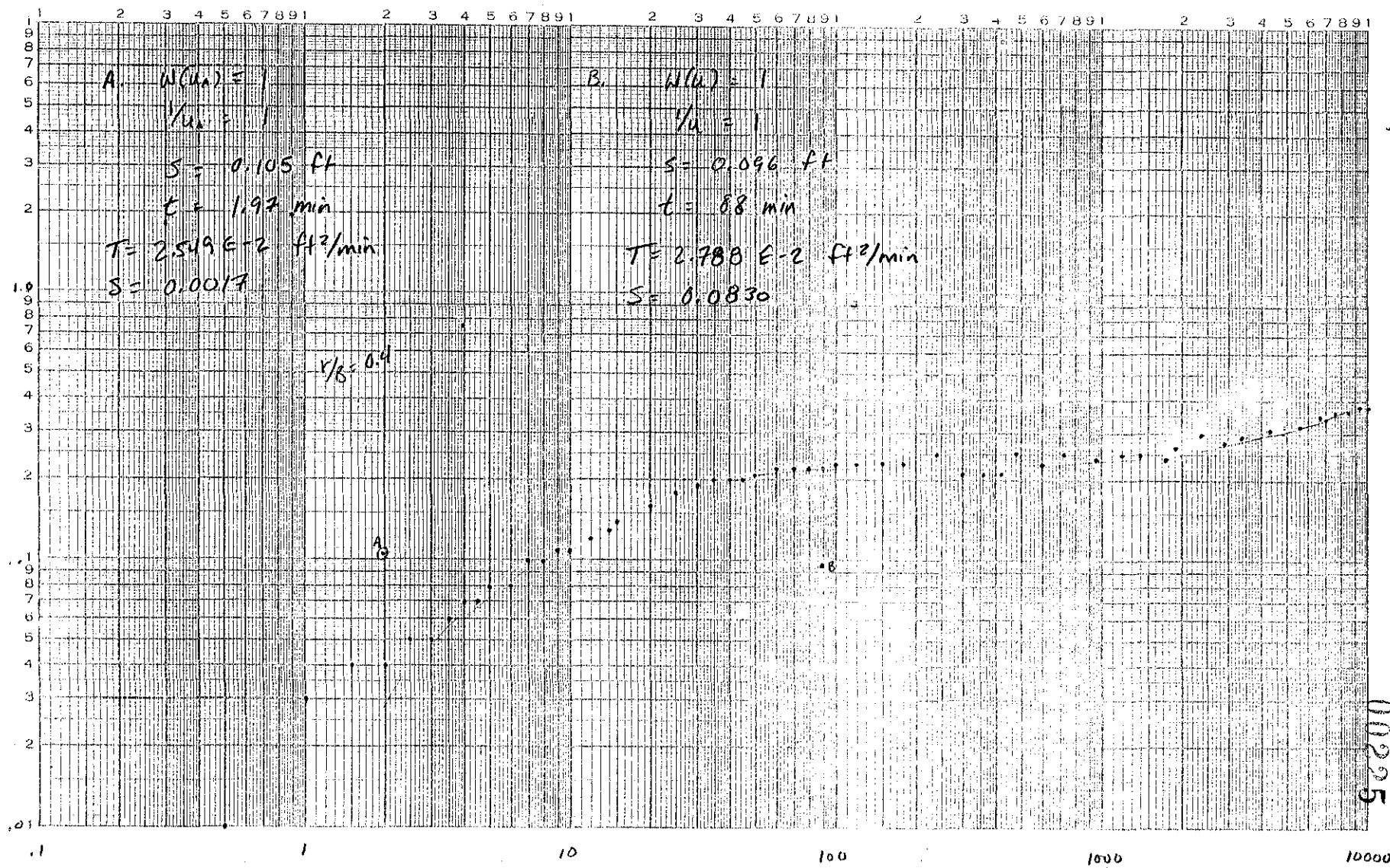
$$1/u = 1$$

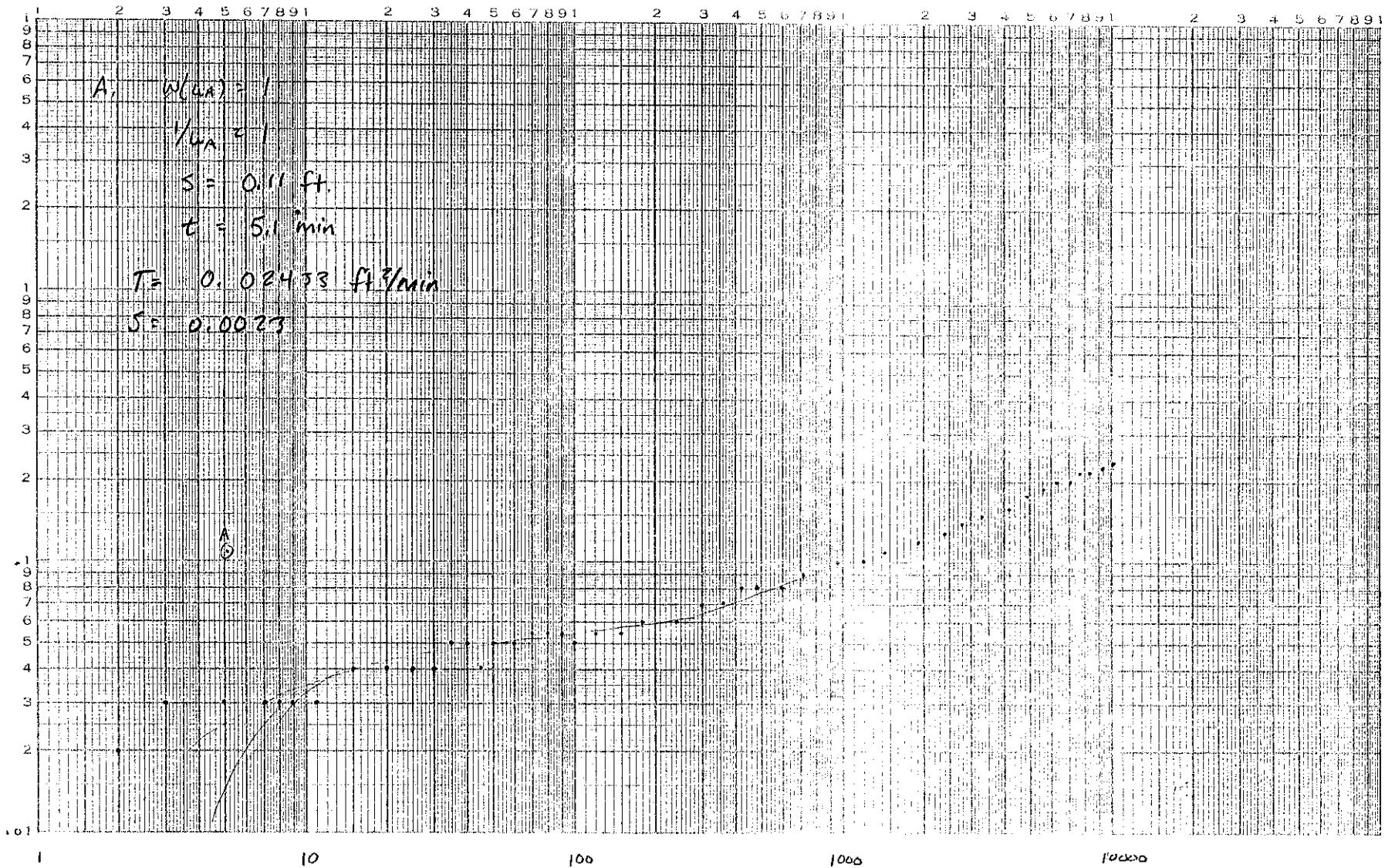
$$S = 0.096 \text{ ft}$$

$$t = 8.8 \text{ min}$$

$$T = 2.780 E - 2 \text{ ft}^2/\text{min}$$

$$S = 0.0830$$

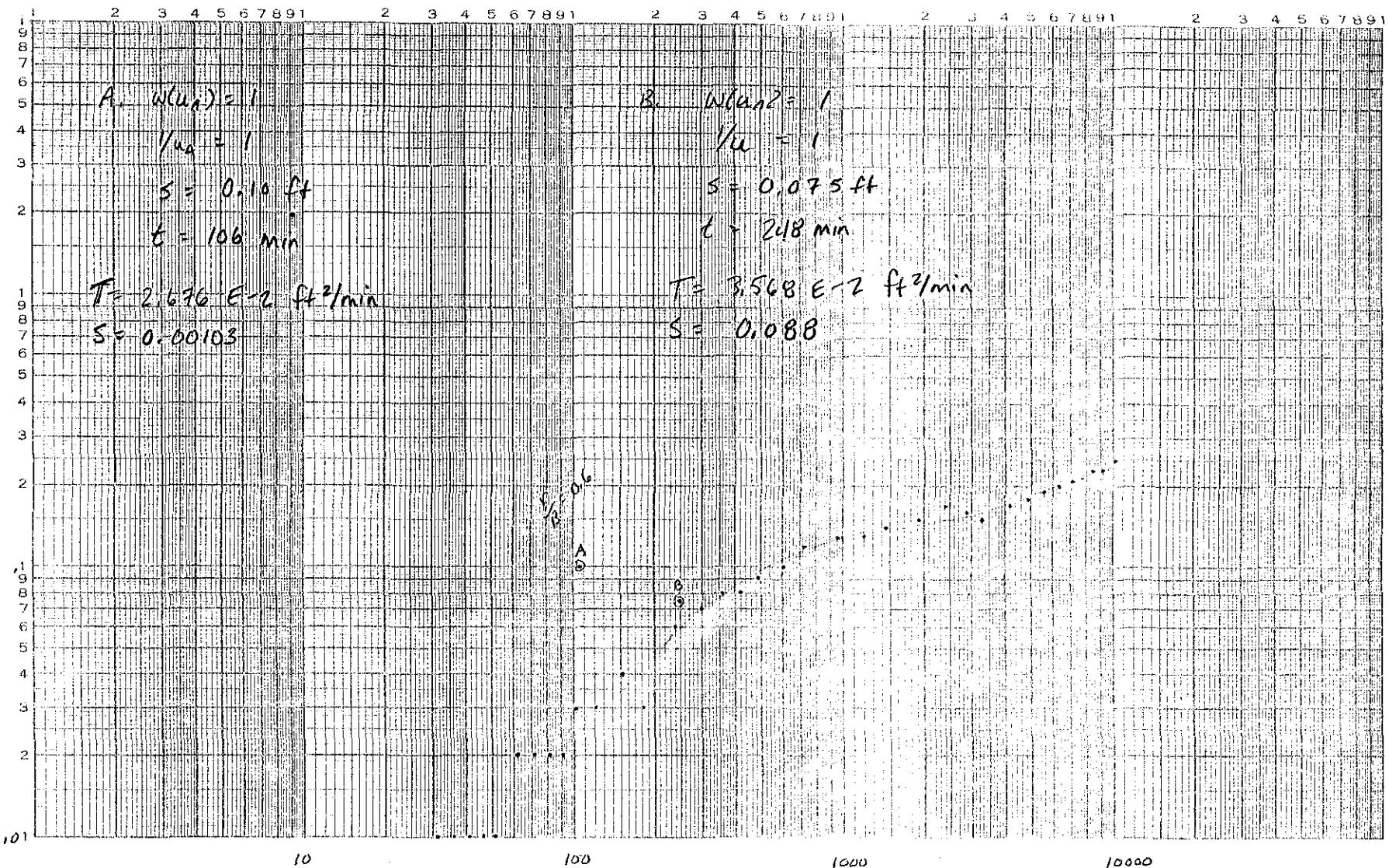


R-3 $r = 14.68 \text{ ft}$ $Q = 3.363 \text{ E-2 ft}^3/\text{min}$ 

00226

time (min)

R-4

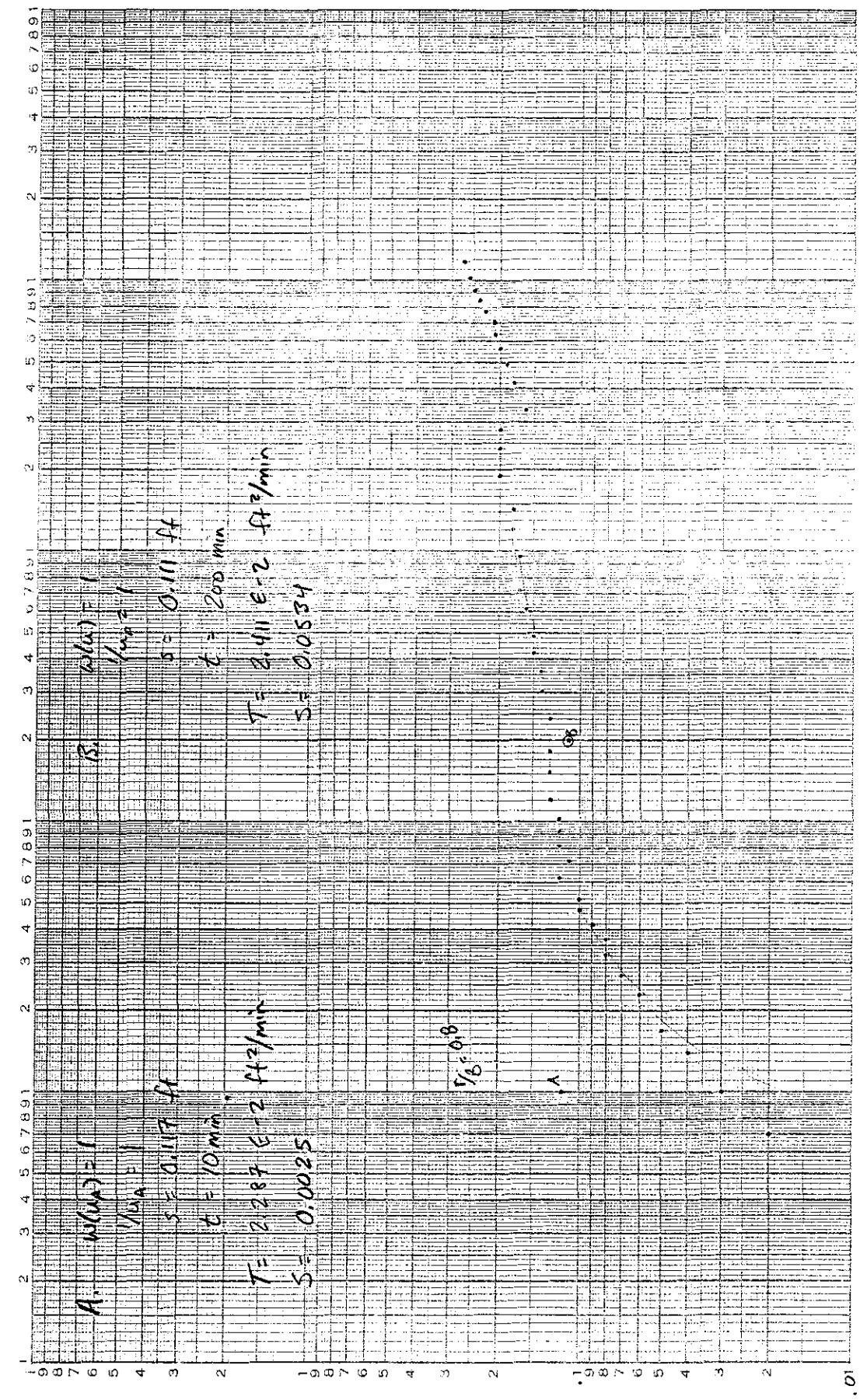
 $r = 20.03$ 

time (min)

46200

00228

$$R-5 \quad r = 19.00 \quad Q = 3.363 E^{-2} \text{ ft}^3/\text{min}$$

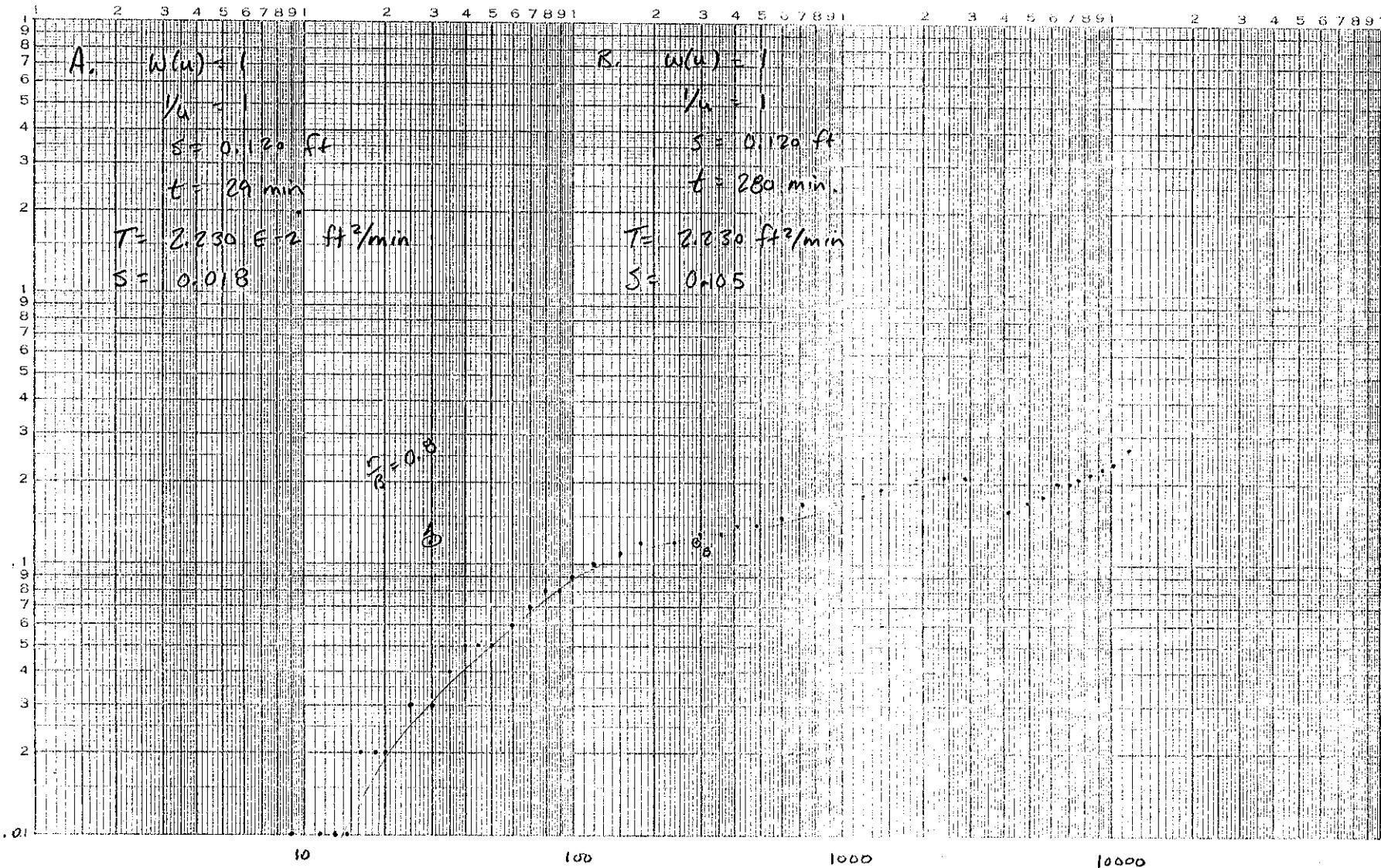


R-6

$$r = 15.44 \text{ ft}$$

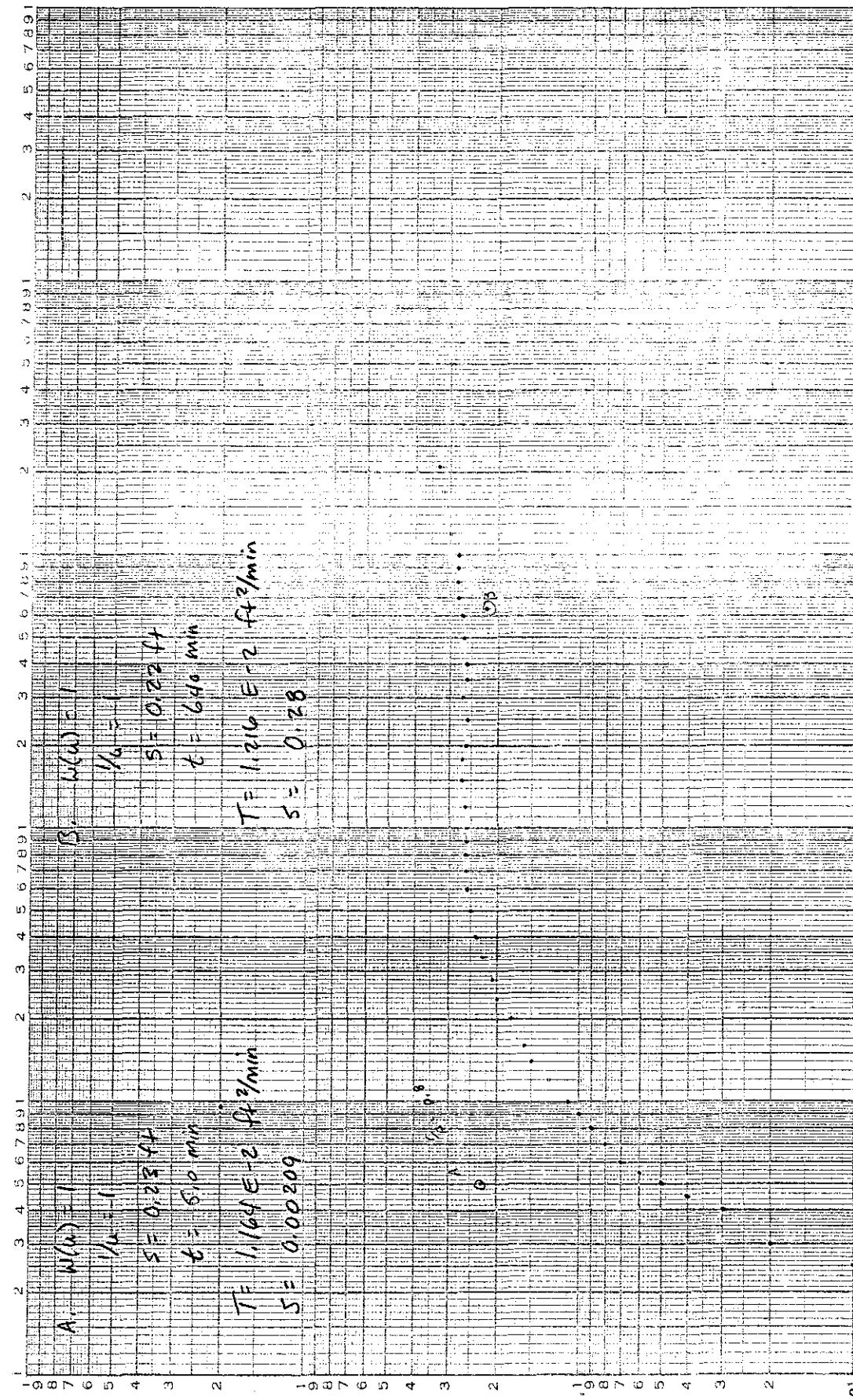
$$Q = 3.363 \times 10^{-2} \text{ ft}^3/\text{min}$$

Full logarithmic 3 x 5

 $t \text{ (min)}$

00229

$$R-7 \quad r = 10.54 \text{ ft} \quad Q = 3.863 E - 2 \text{ ft}^3/\text{min}$$



1000

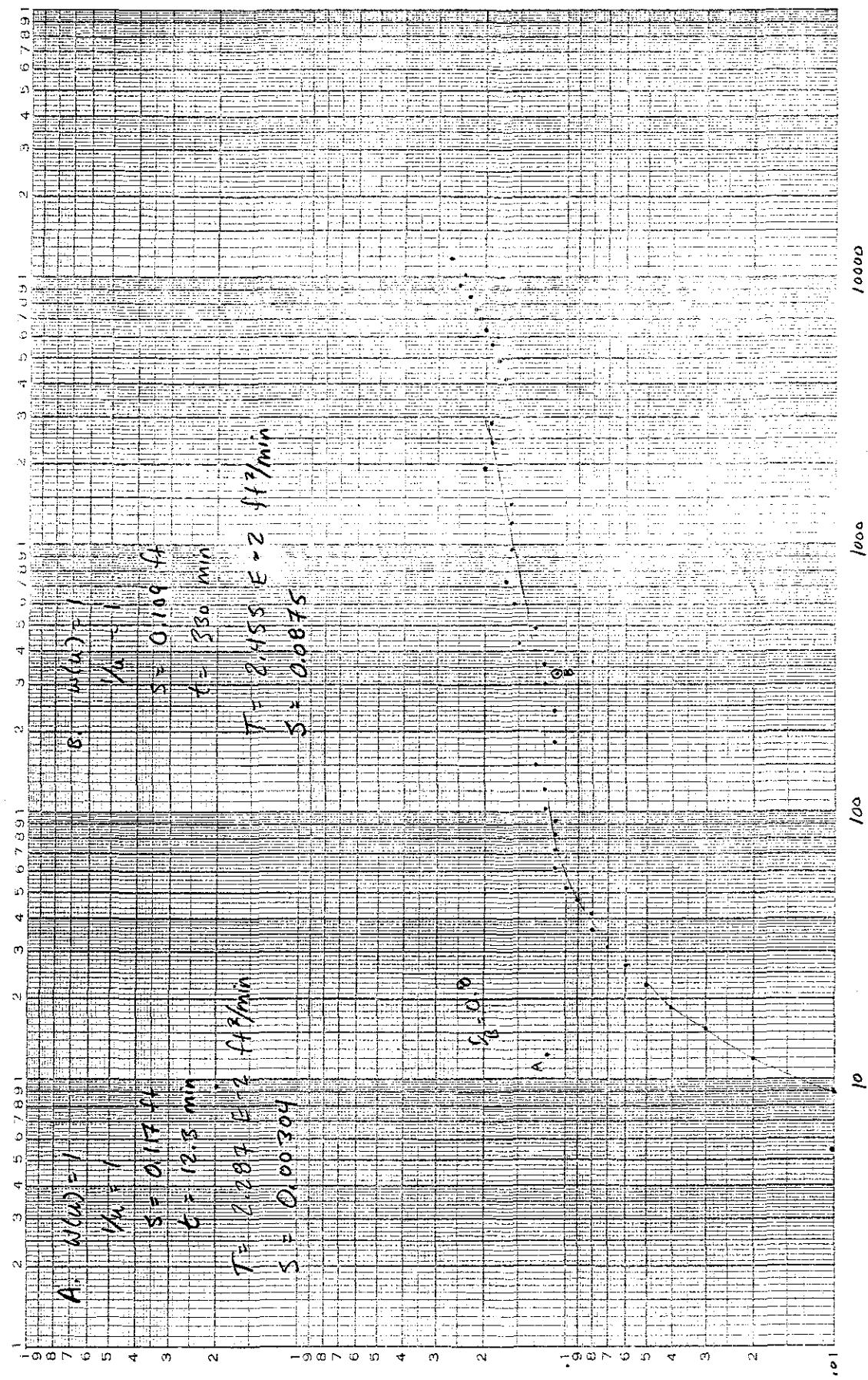
100

10

.01

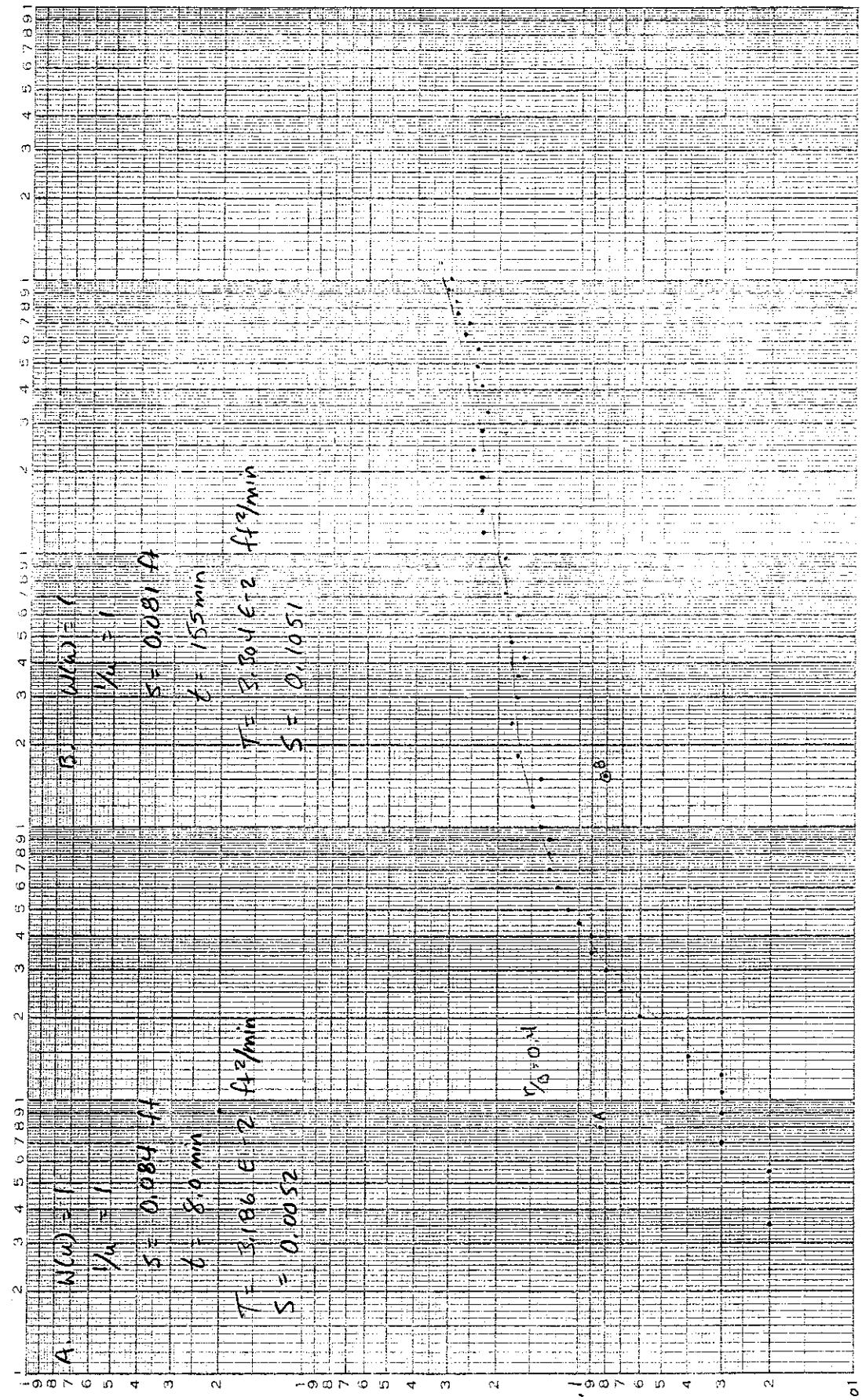
00231

R-8 r=19.25



00222

$$R-9 \quad r = 13.96 \text{ ft} \quad Q = 3.363 \text{ ft}^3/\text{min}$$



10000

1000

100

10

time (min)

5
(ft)

00223

$$R-10 \quad r = 6.36 \text{ ft} \quad Q = 3.363 \text{ cfs} \quad f_4^3/\text{min}$$

A. $\ln(\alpha) \Sigma$

$$\ln = 1$$

$$5 = 0.95 \text{ ft}$$

$$t = 6.0 \text{ min}$$

$$T = 1.372 \text{ ft}^2 \text{ ft}^2/\text{min}$$

$$S = 0.0217$$

S
(ft.)

10
100

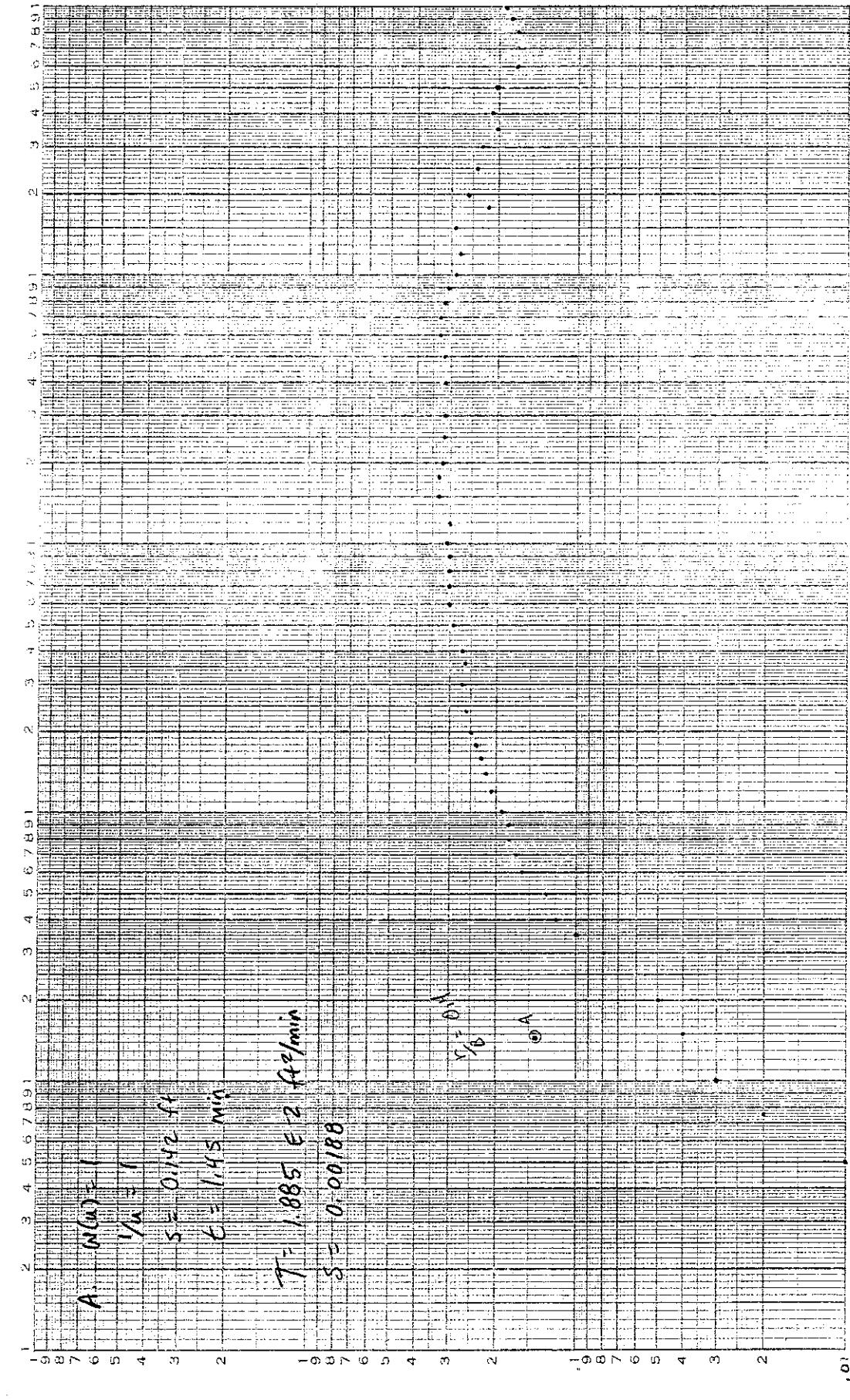
time (min.)

1000

00234

R-II
 $r = 7.63$

(transducer)



R-12

$r = 14.32 \text{ ft}$

NATIONAL
12-191
Scale 1:1000

00235

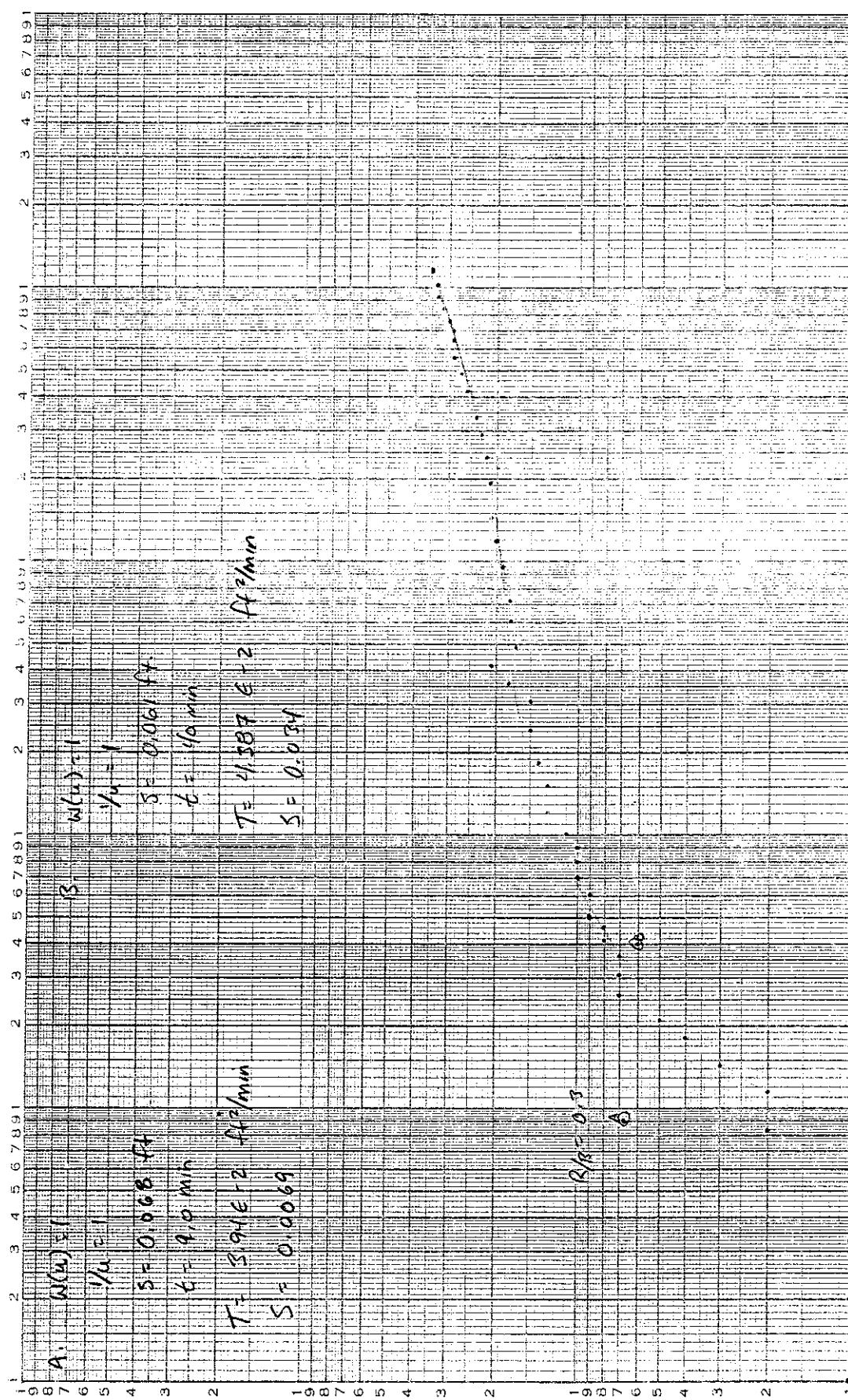
00001

1000

100

10

time (min)

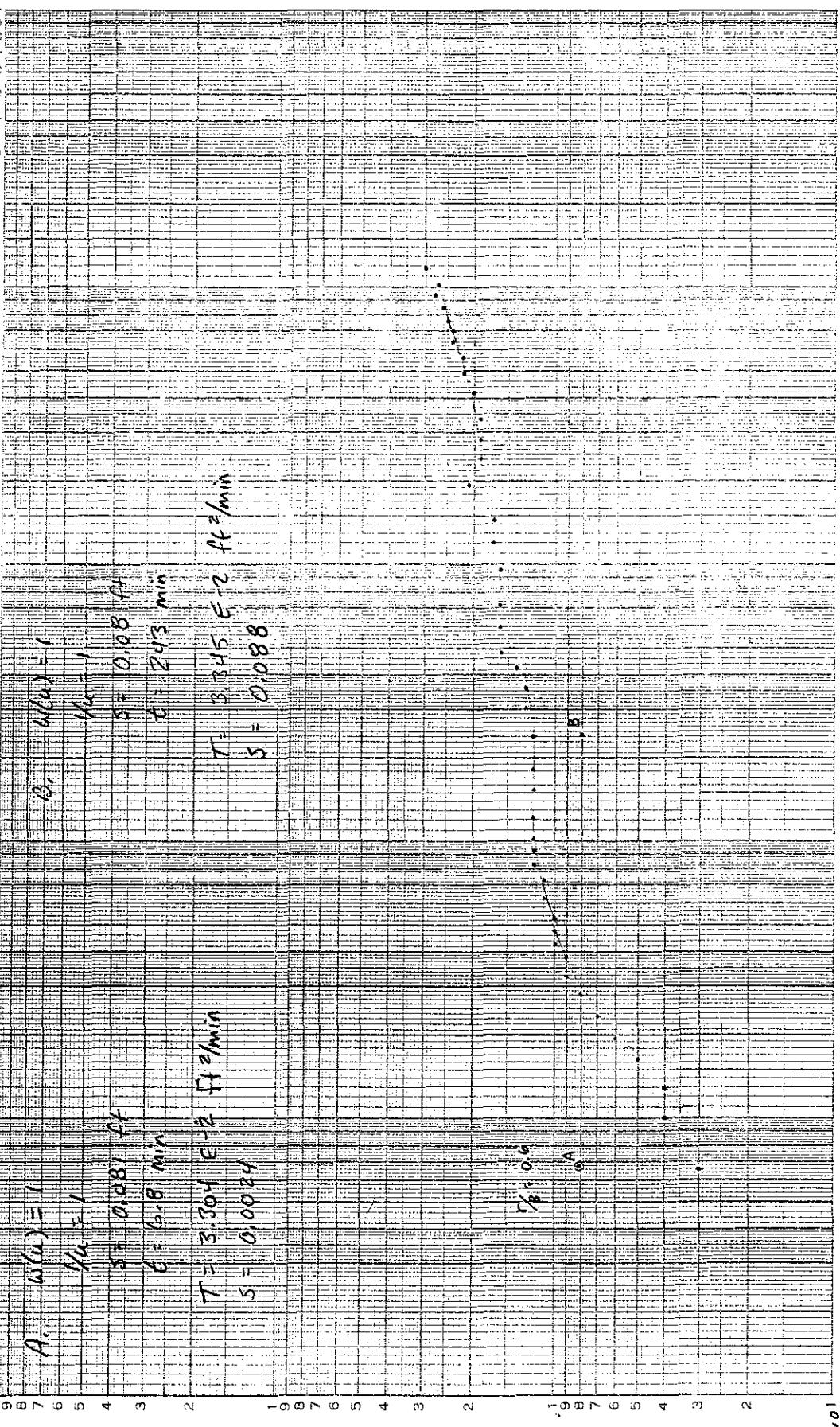


00226

R-13

$$r = 19.20 \text{ ft}$$

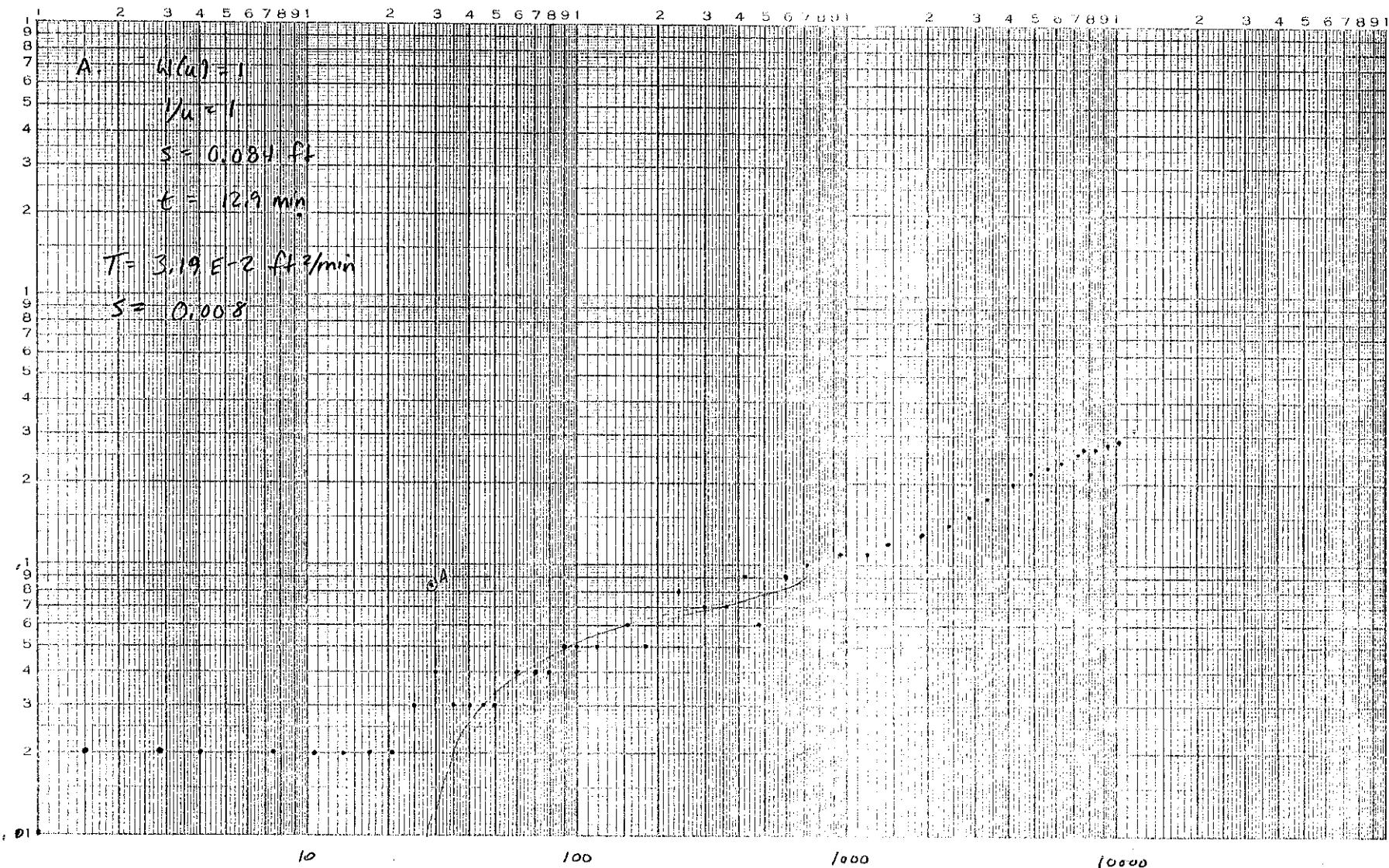
$$Q = 3.363 \text{ ft}^3/\text{min}$$



R-14

$$r = 14.35$$

$$Q = 3.363 E-2 \text{ ft}^3/\text{min}$$



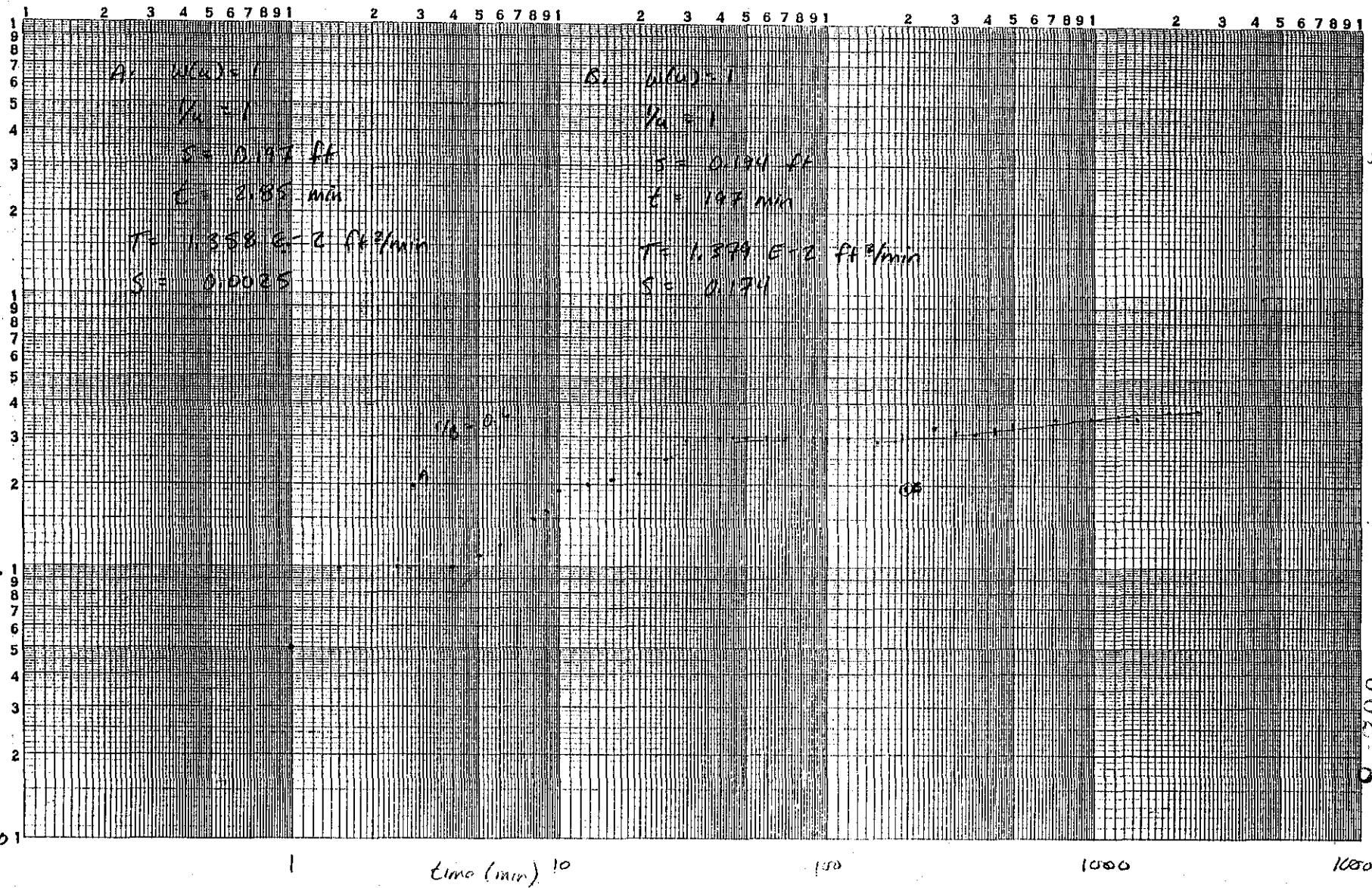
time (min)

43300

R=15

r = 7.90 ft

Q = 3.363 E - 2 ft³/min

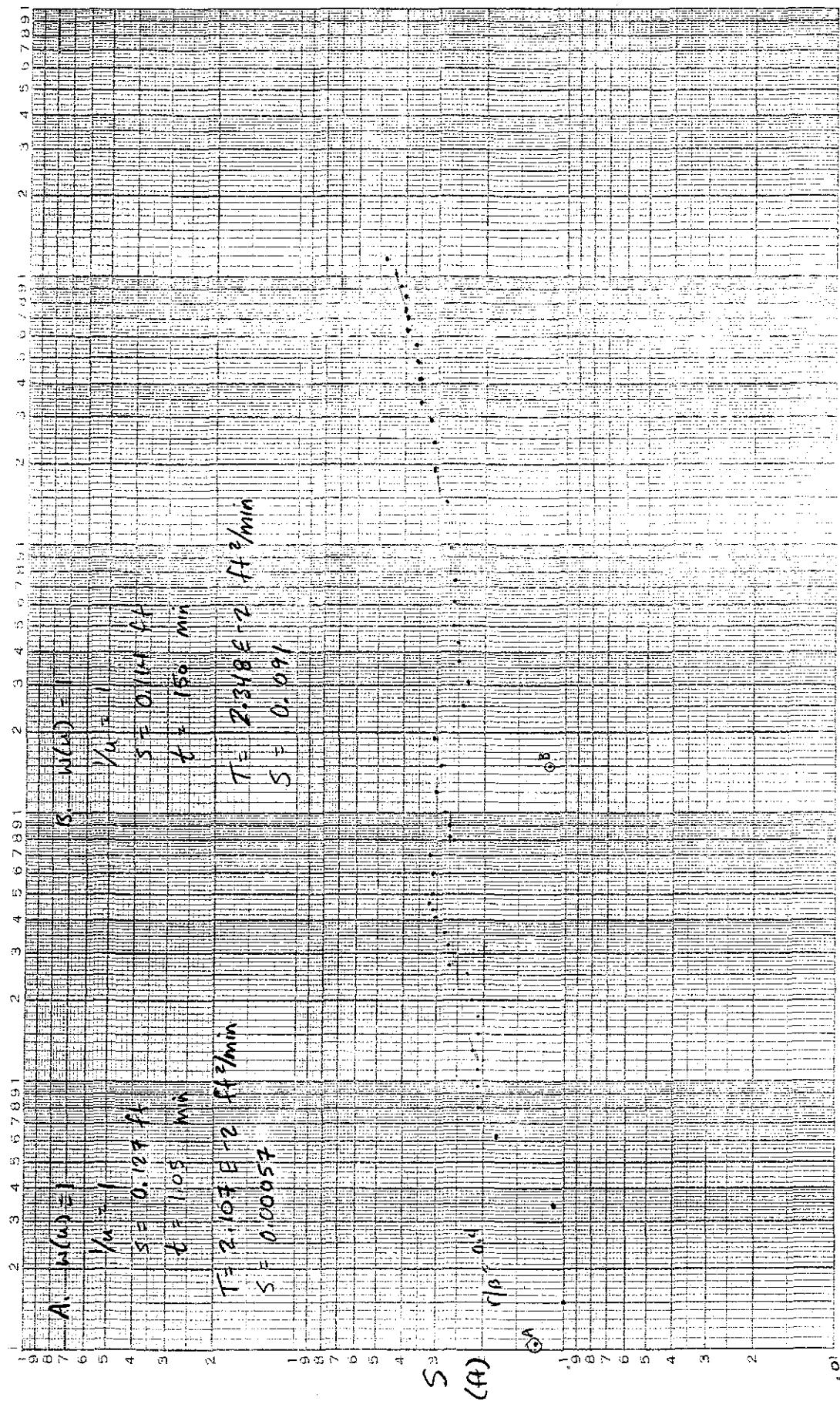


00229

R-16

$r = 12.46 \text{ ft}$

$Q = 3.363 \text{ E-2 ft}^3/\text{min}$



00000

10000

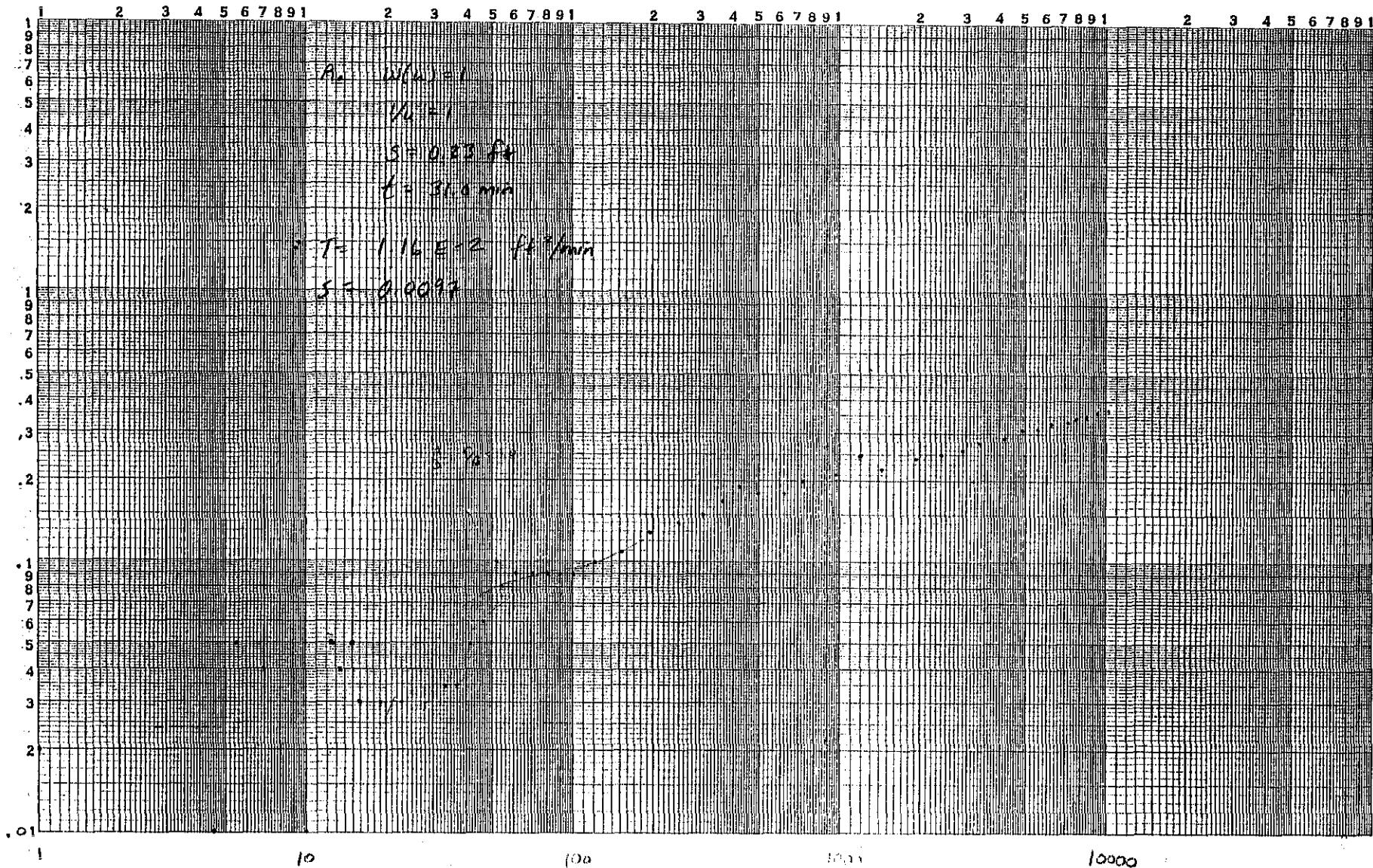
1000

100

time (min)

R-17

$$r = 12.2 \text{ ft}$$

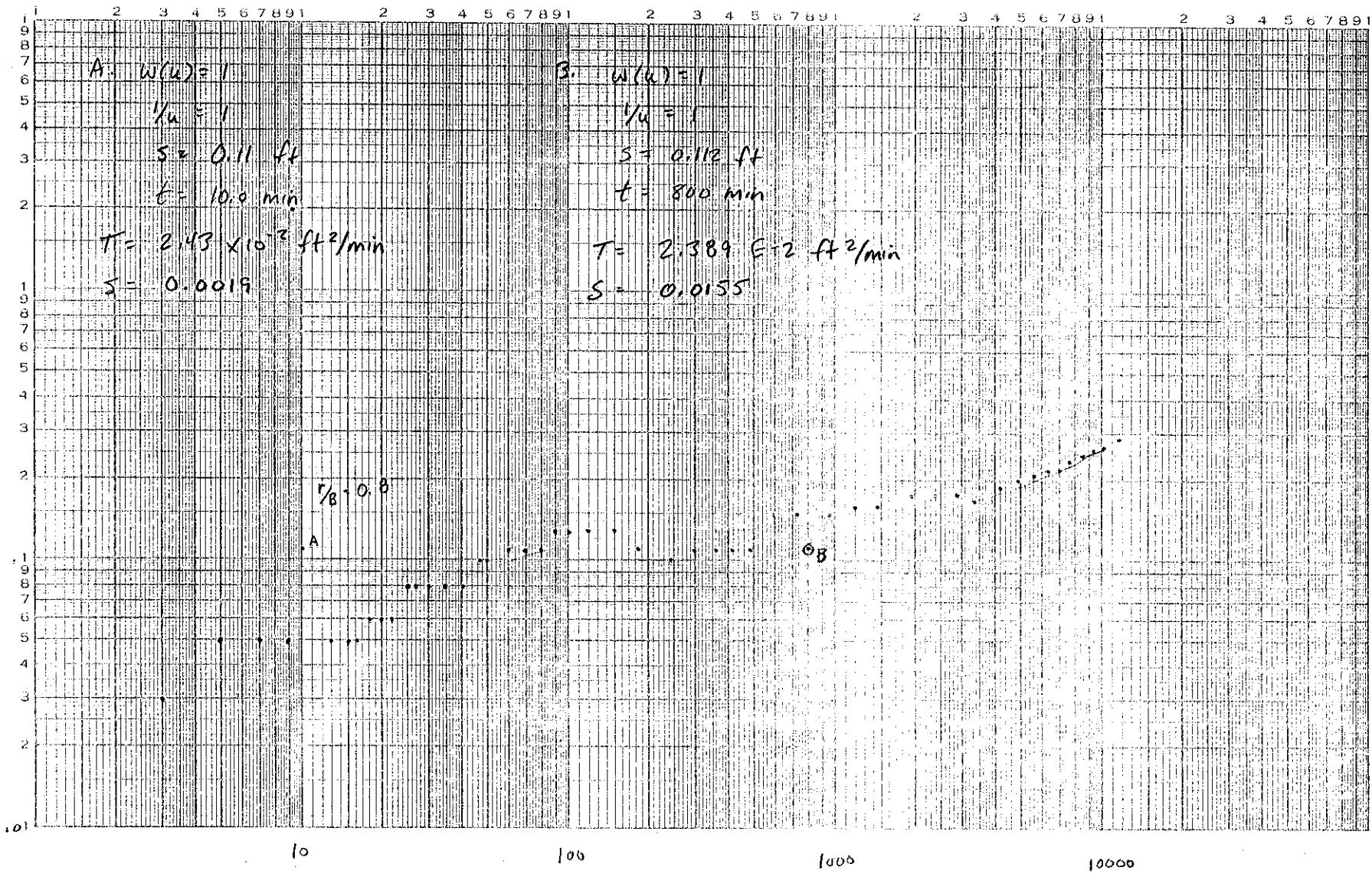


00240

R-18

$$r = 22.22 \text{ ft}$$

$$Q = 3.363 \times 10^{-2} \text{ ft}^3/\text{min}$$



time (min)

00241

00242

oepol

10

501

9

A graph showing a series of data points plotted against time t . The x-axis is labeled $t = 116.4 E-2 s$ with values from 0 to 1.0. The y-axis is labeled $S = 0.0018$ with values from 0 to 0.5. The data points form a curve that starts at (0,0), rises to a peak around $t=0.4$, and then gradually declines towards zero.

(transl.)

$b_1 b_2 = 1$

b1-3

11-2-3-1091

UNIVERSITY OF TORONTO LIBRARIES

- 0.23 -

卷之三

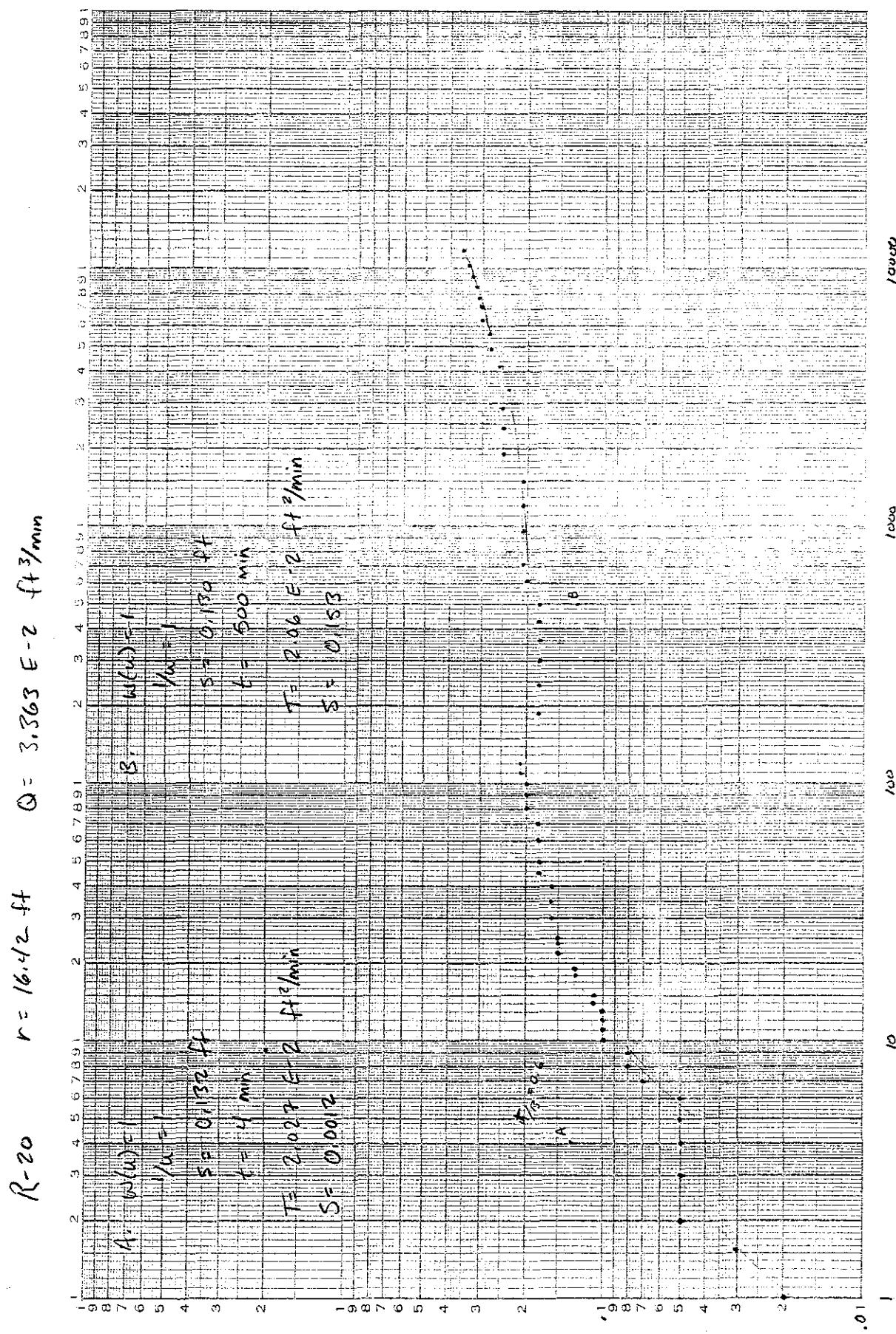
150

新編 通志 卷之三十一

1182954

$$bh \cdot 2 = 1$$

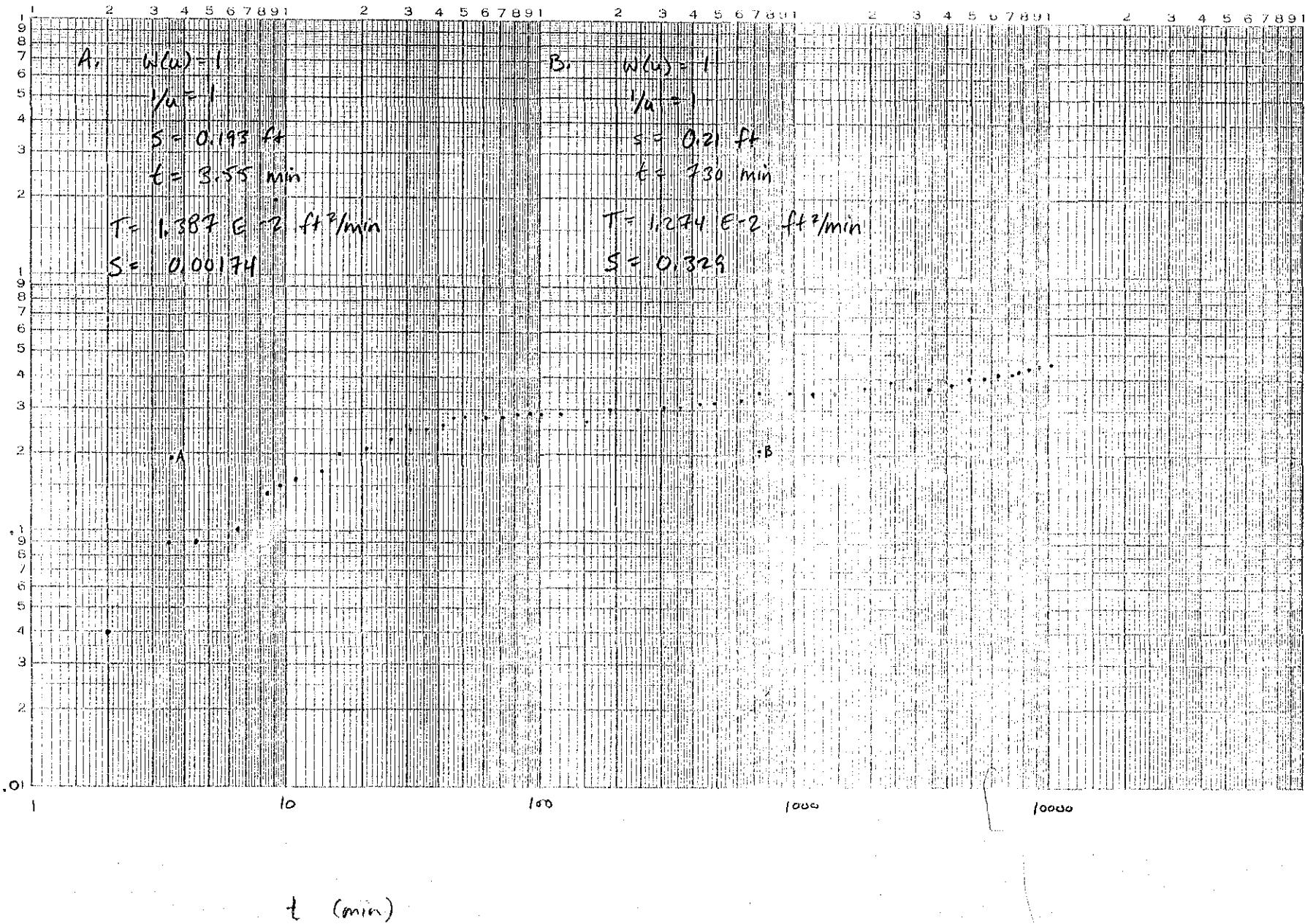
00243



R-21

$$r = 10.63 \text{ ft}$$

$$Q = 3.363 \times 10^{-2} \text{ ft}^3/\text{min}$$



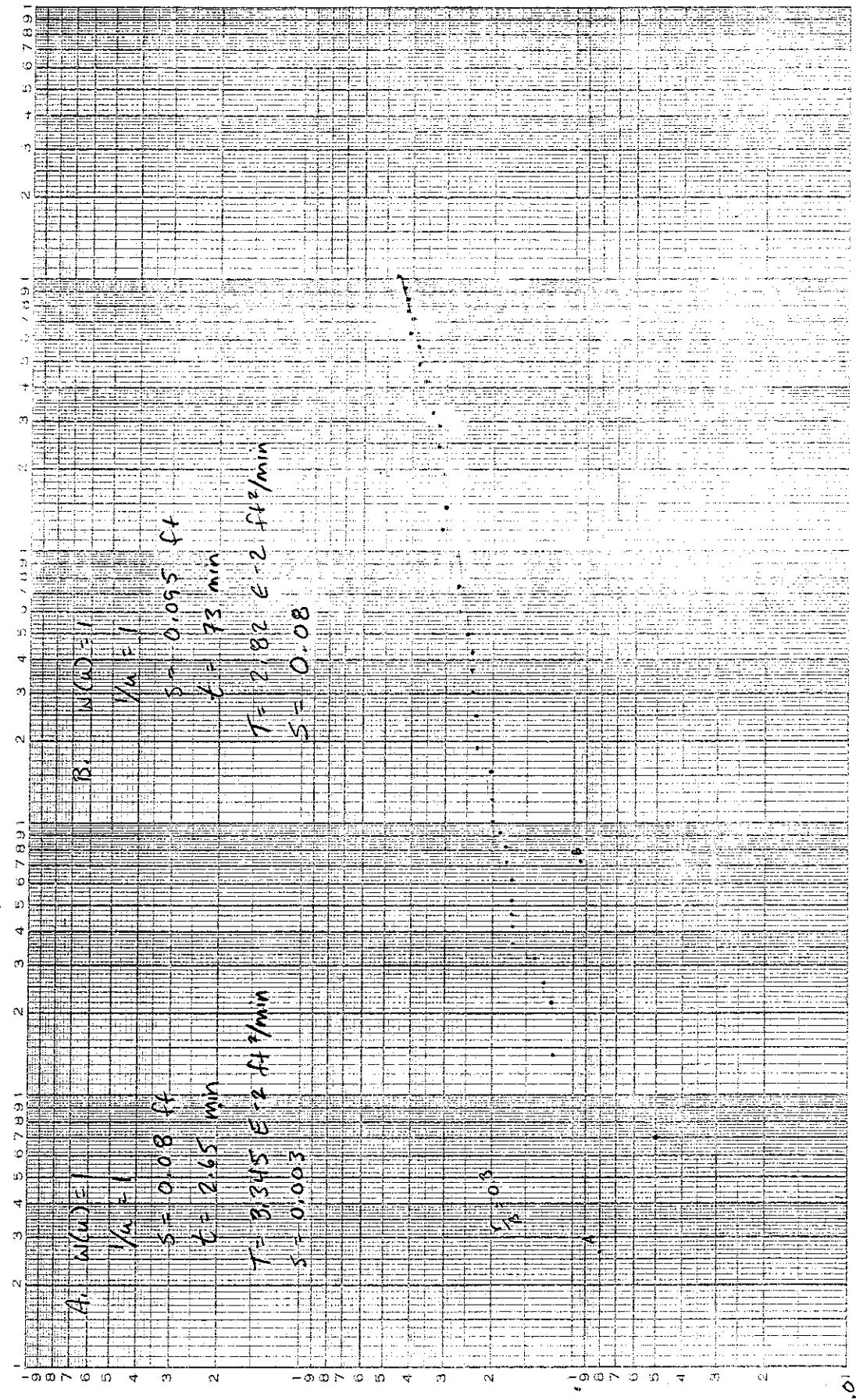
00244

00245

R-22

$r_c = 10.02$

$$Q = 3.363 E^{-2} \text{ ft}^3/\text{min}$$



1000

100

10

1

time (min)

00246

$$R-23 \quad r = 17.03 \text{ ft} \quad Q = 3.363 \text{ } \epsilon^{-2} \text{ ft}^3/\text{min}$$

A.

$$\begin{aligned} h(a) &= 1 \\ 1/a &= 1 \\ s &= 0.097 \text{ ft} \\ t &= 6.3 \text{ min} \\ T &= 3.976 \text{ ft}^2/\text{min} \\ s &= 0.00096 \end{aligned}$$

A.

$$\begin{aligned} h(a) &= 1 \\ 1/a &= 1 \\ s &= 0.077 \text{ ft} \\ t &= 6.7 \text{ min} \\ T &= 3.476 \text{ ft}^2/\text{min} \\ s &= 0.00096 \end{aligned}$$

A.

B.

$$\begin{aligned} h(a) &= 1 \\ 1/a &= 1 \\ s &= 0.076 \text{ ft} \\ t &= 220 \text{ min} \\ T &= 3.521 \text{ ft}^2/\text{min} \\ s &= 0.107 \end{aligned}$$

B.

$$\begin{aligned} h(a) &= 1 \\ 1/a &= 1 \\ s &= 0.064 \text{ ft} \\ t &= 100 \text{ min} \\ T &= 3.330 \text{ ft}^2/\text{min} \\ s &= 0.096 \end{aligned}$$

A.

 $t \text{ (min)}$

00247

00001

100

100

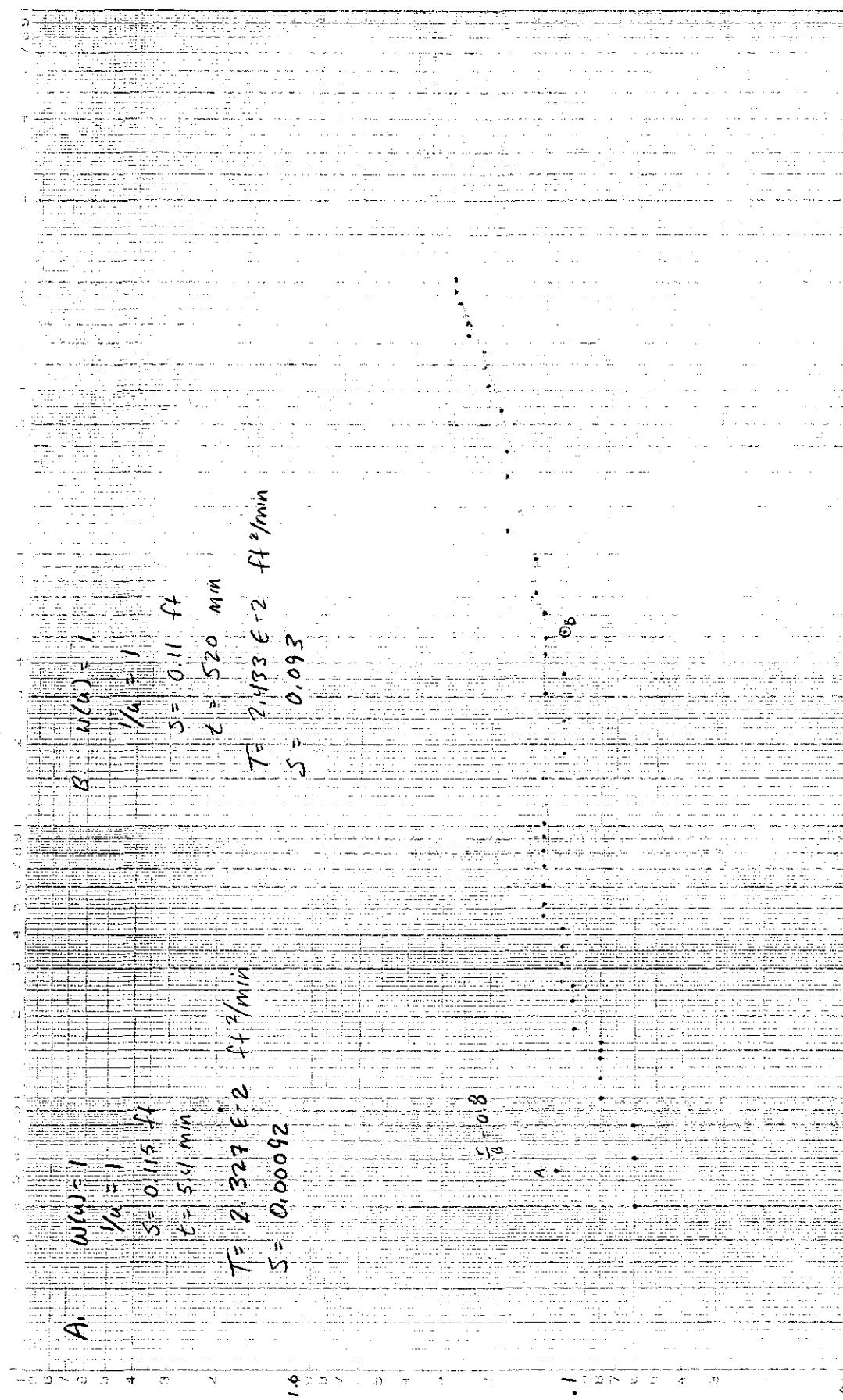
10

Time (min)

P. 24

 $r = 23.35$

$$Q = 2.363 \text{ E-2 ft}^3/\text{min}$$



NATIONAL
12-191

00248

R-25

$$Q = 3.363 \text{ E-2 ft}^3/\text{min}$$

$$\begin{aligned} A &= 0.125 \text{ ft}^2 \\ t &= 0.0029 \text{ min} \\ T &= 2.11 \text{ E-2 ft}^2/\text{min} \\ S &= 0.098 \\ T &= 2.059 \text{ E-2 ft}^2/\text{min} \\ S &= 0.130 \text{ min}^{-1} \end{aligned}$$

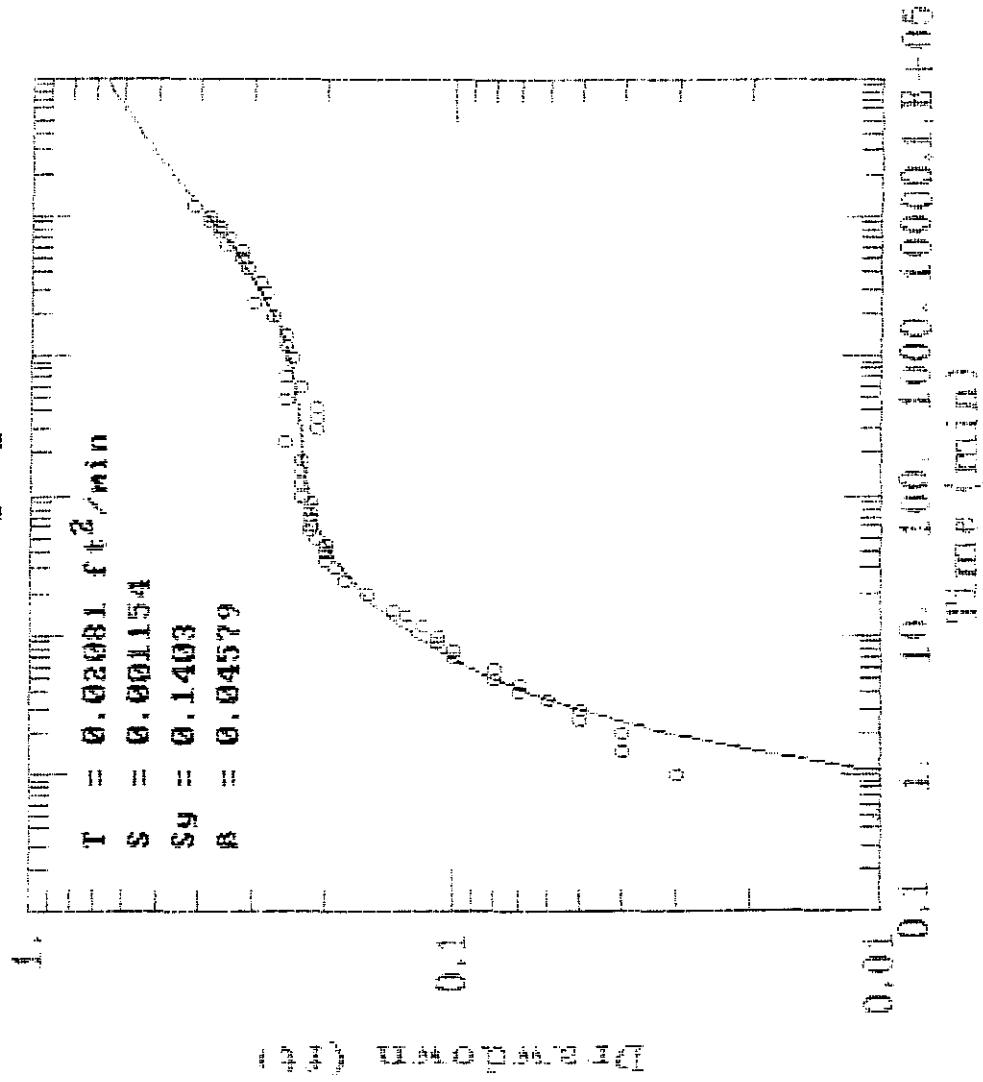
(f+)

00249

Pumping tests, Neuman method - Site 1

00250

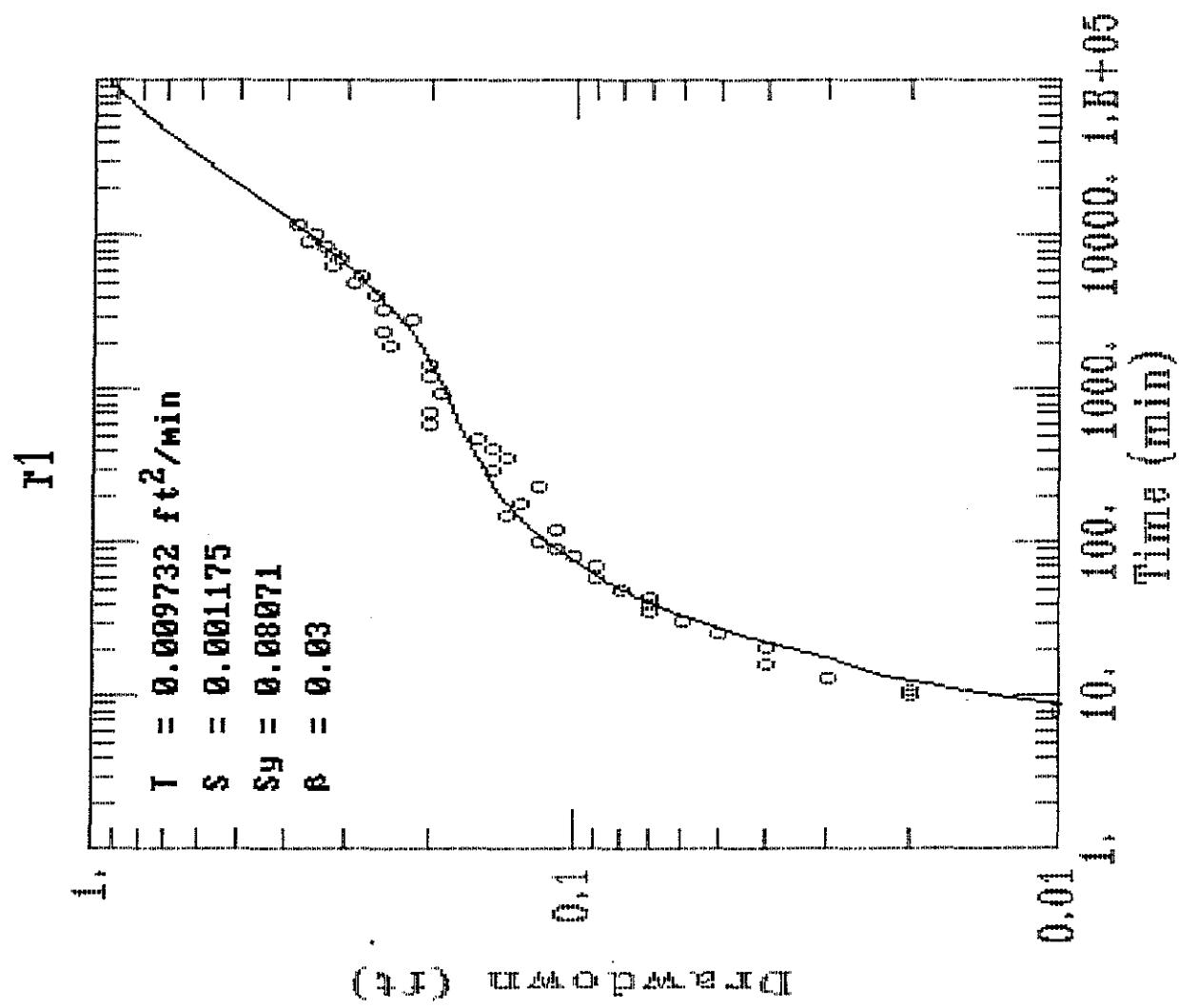
R-2 Pumping Test 1



Sheet 58 - rev.

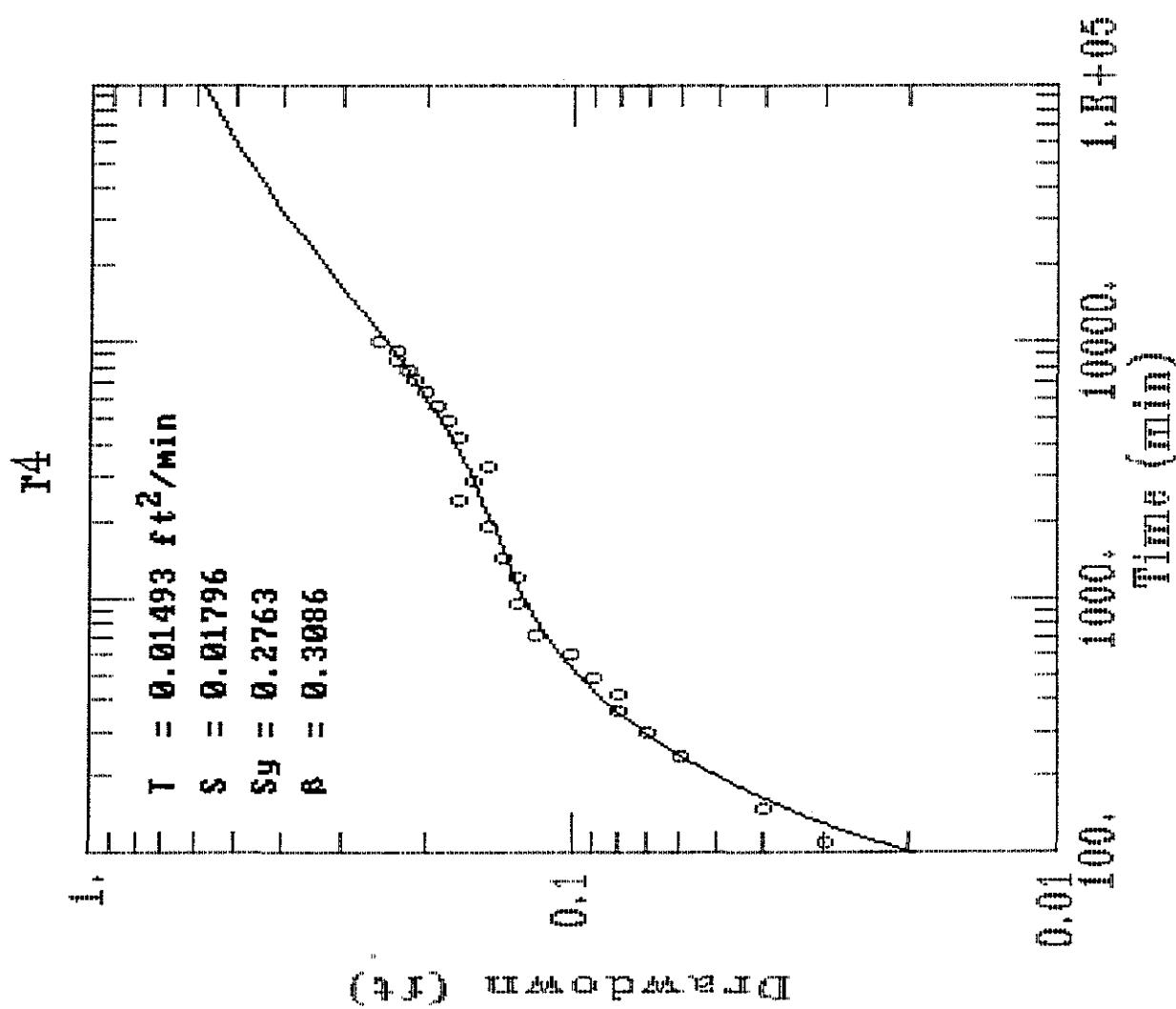
00251

11/9/92

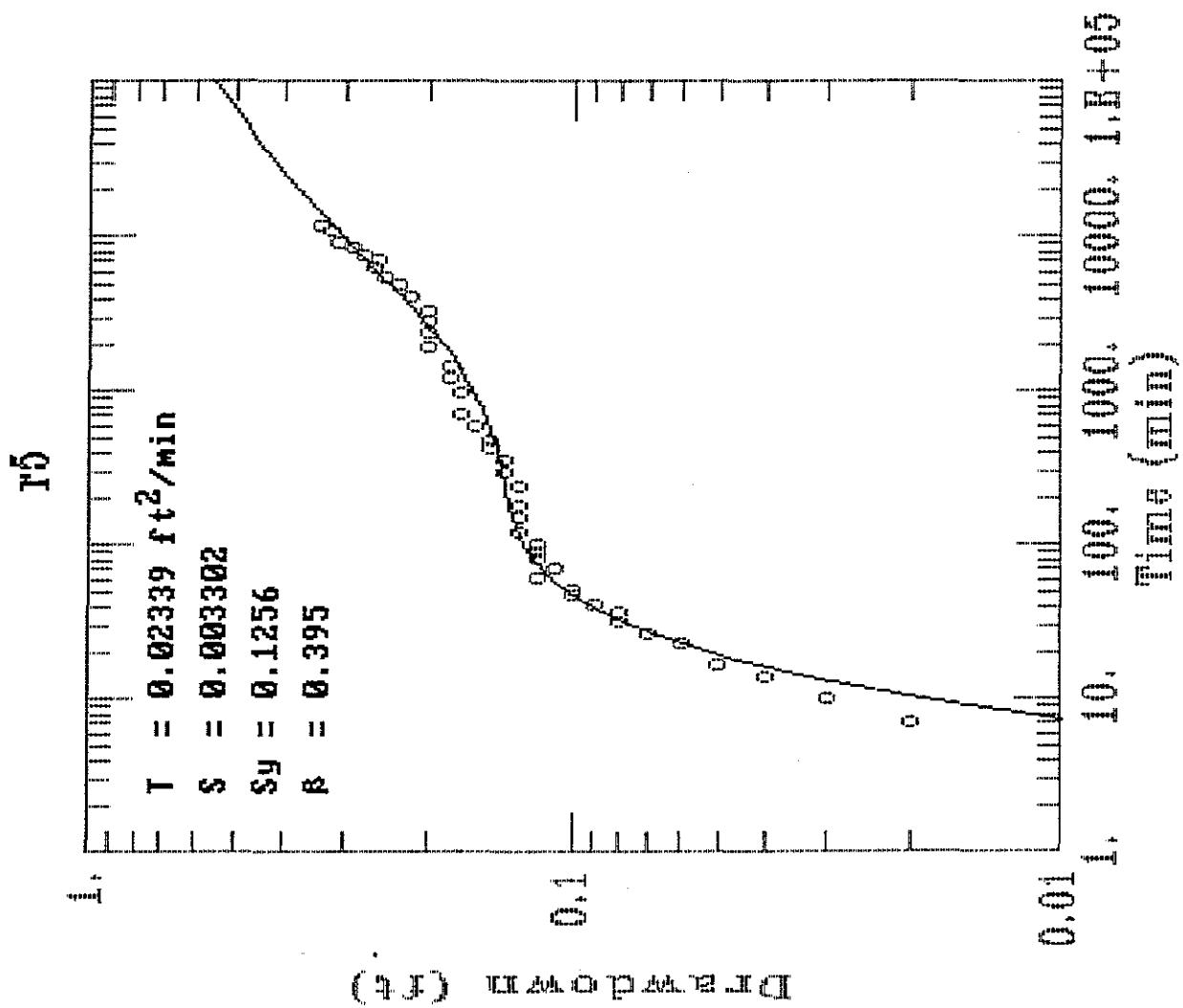


00252

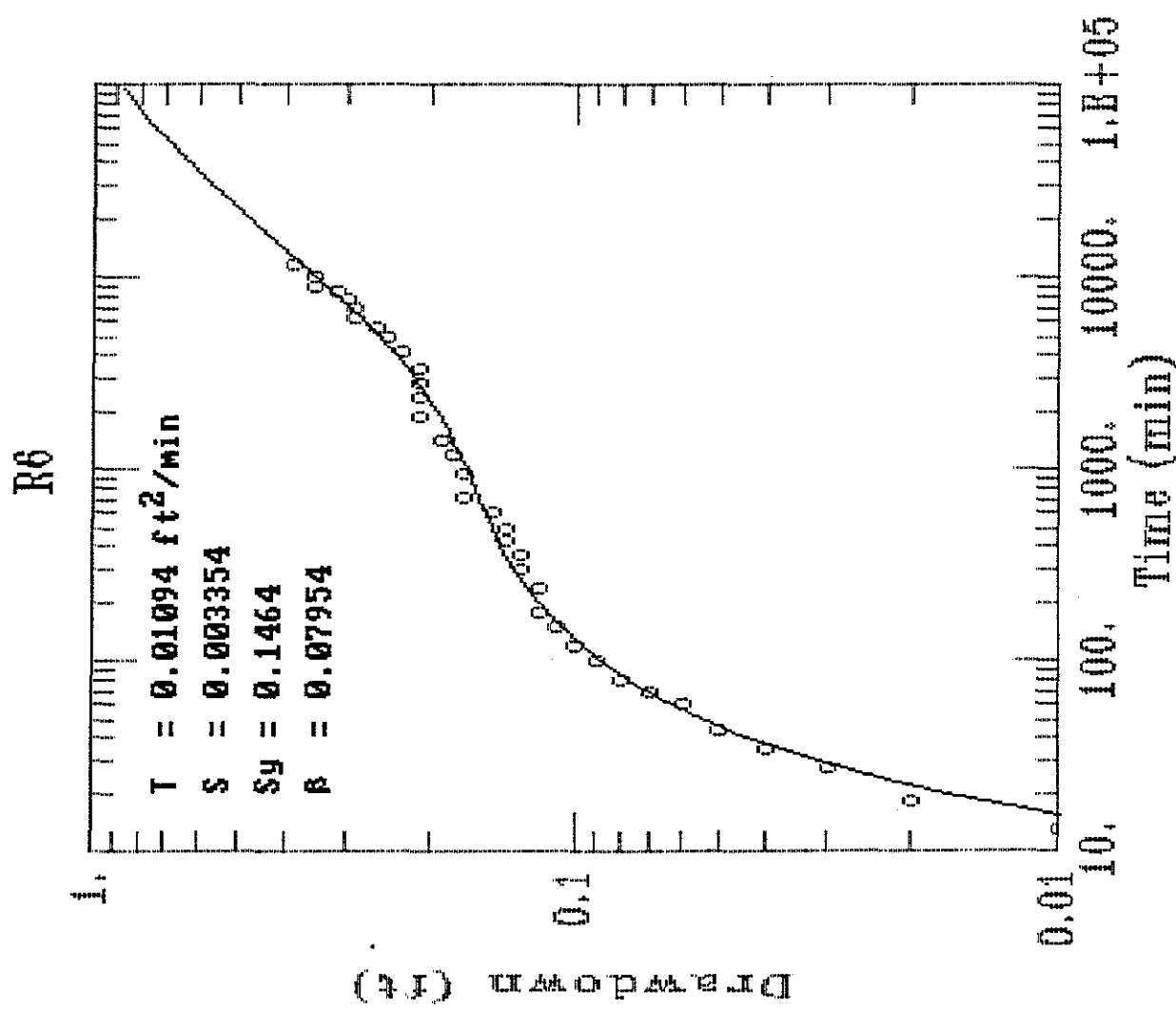
11/13/92



00253

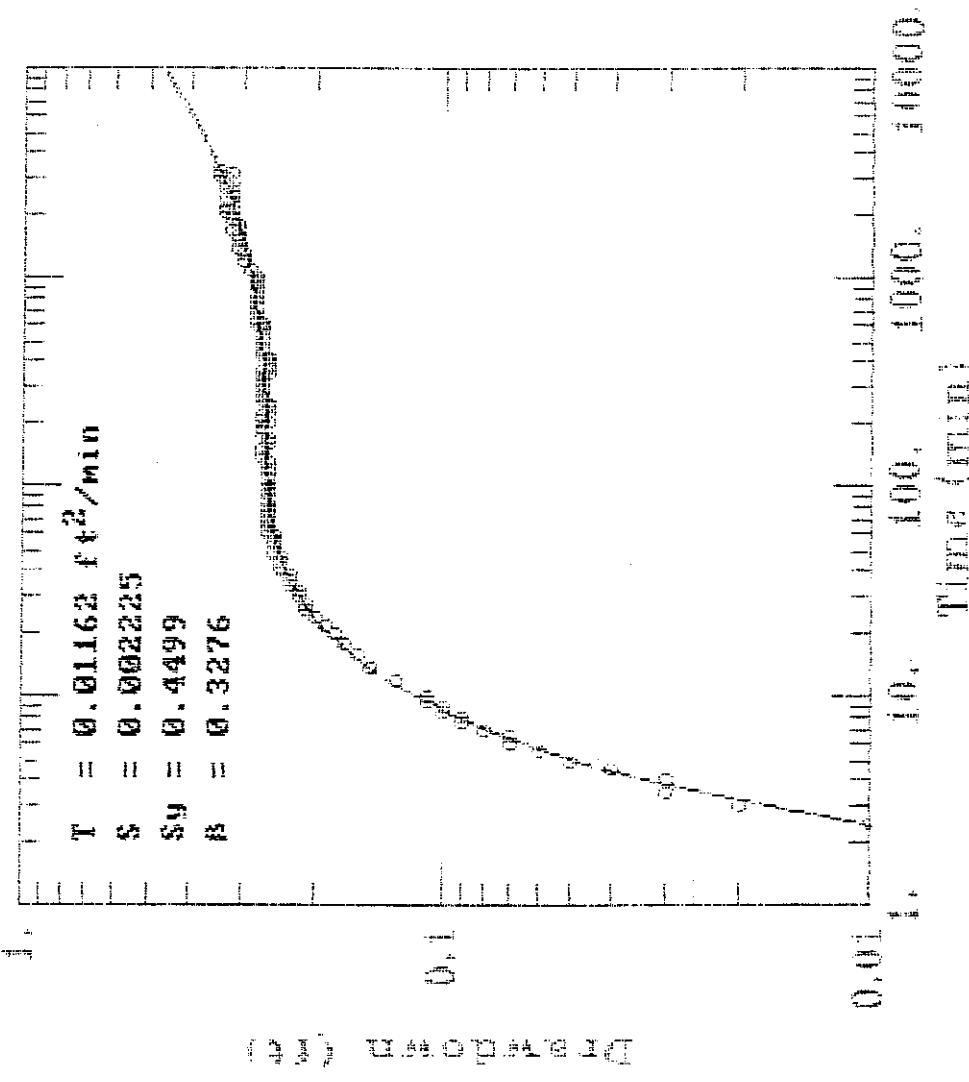


00254

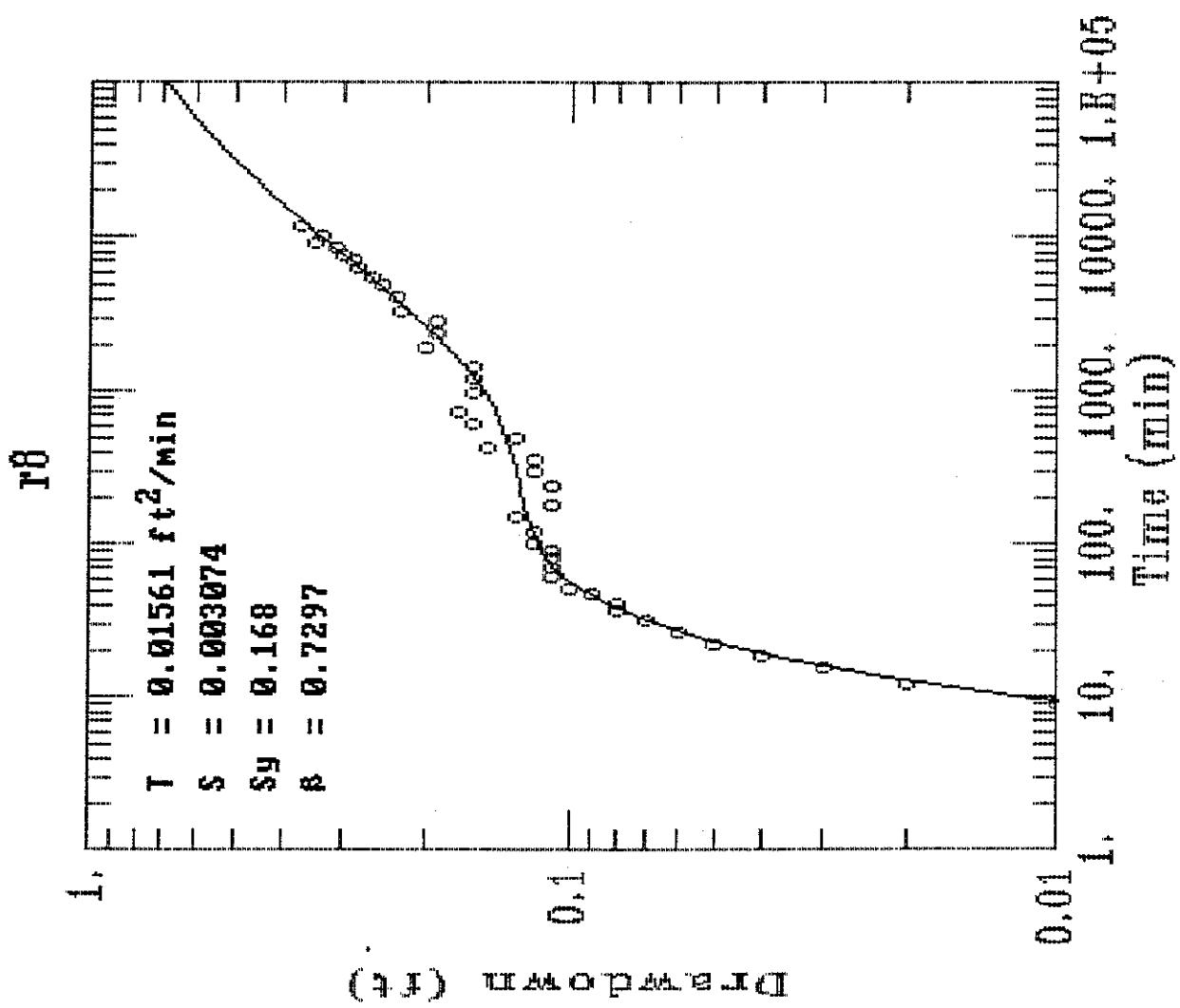


0025

R-7 Pump Test 1

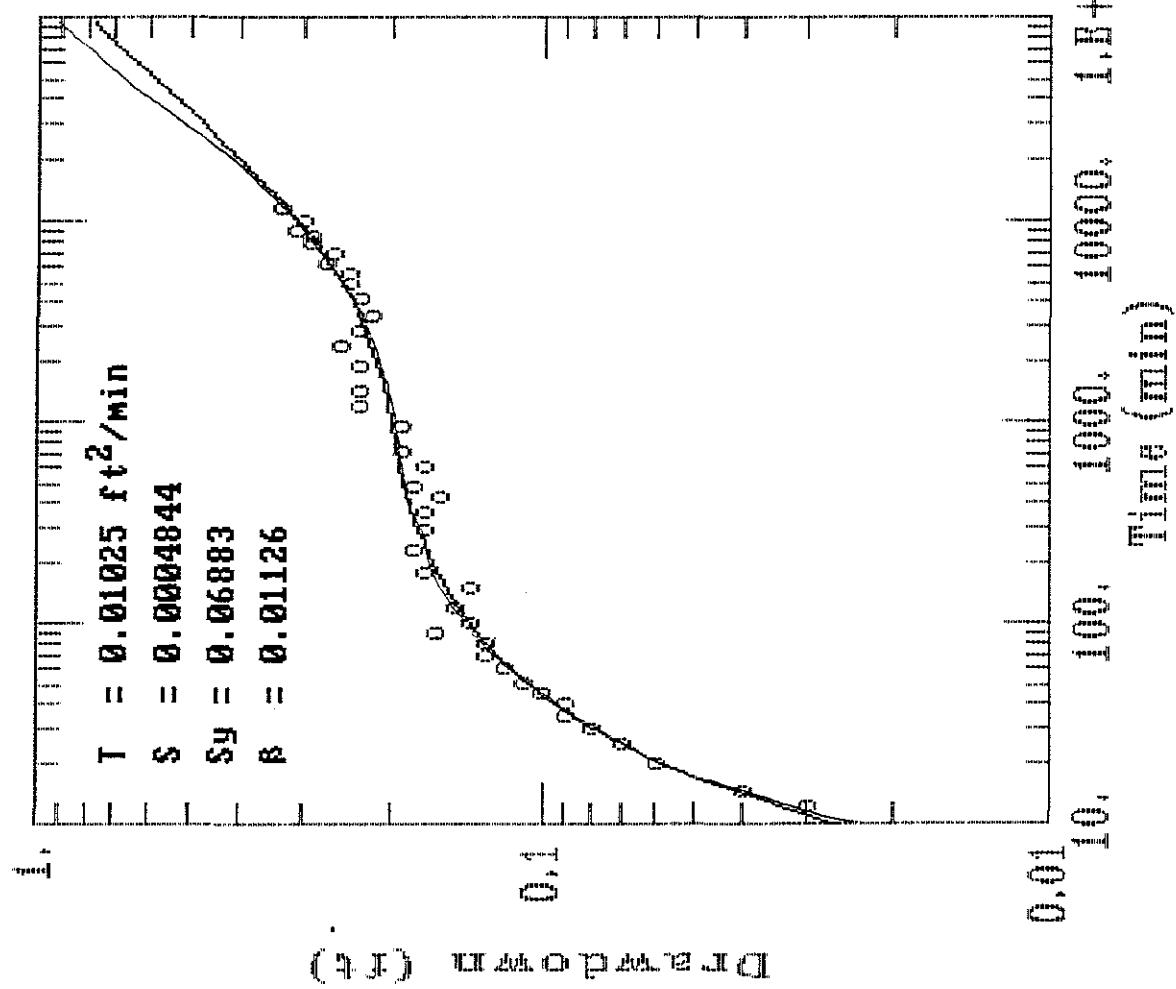


00256



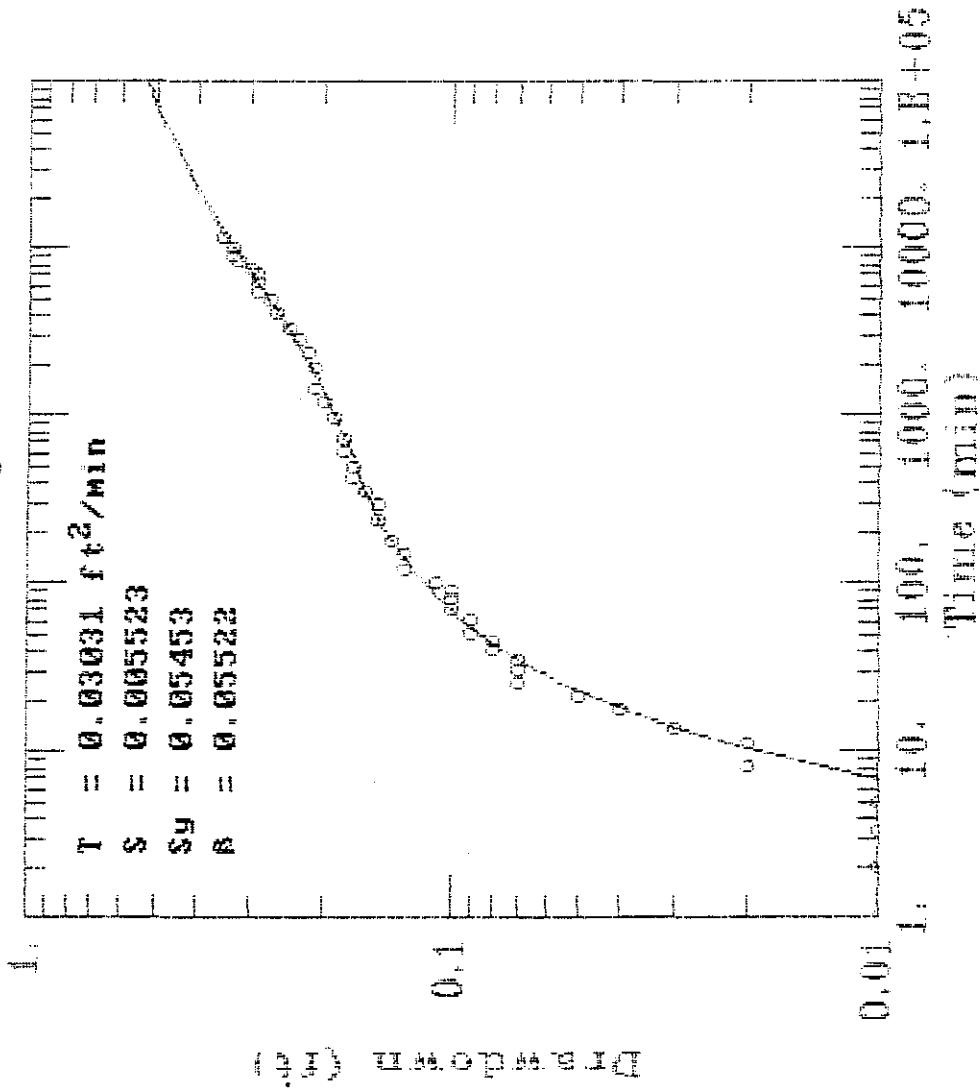
00257

r-9b.dat



00258

K-12 Pump Test 1

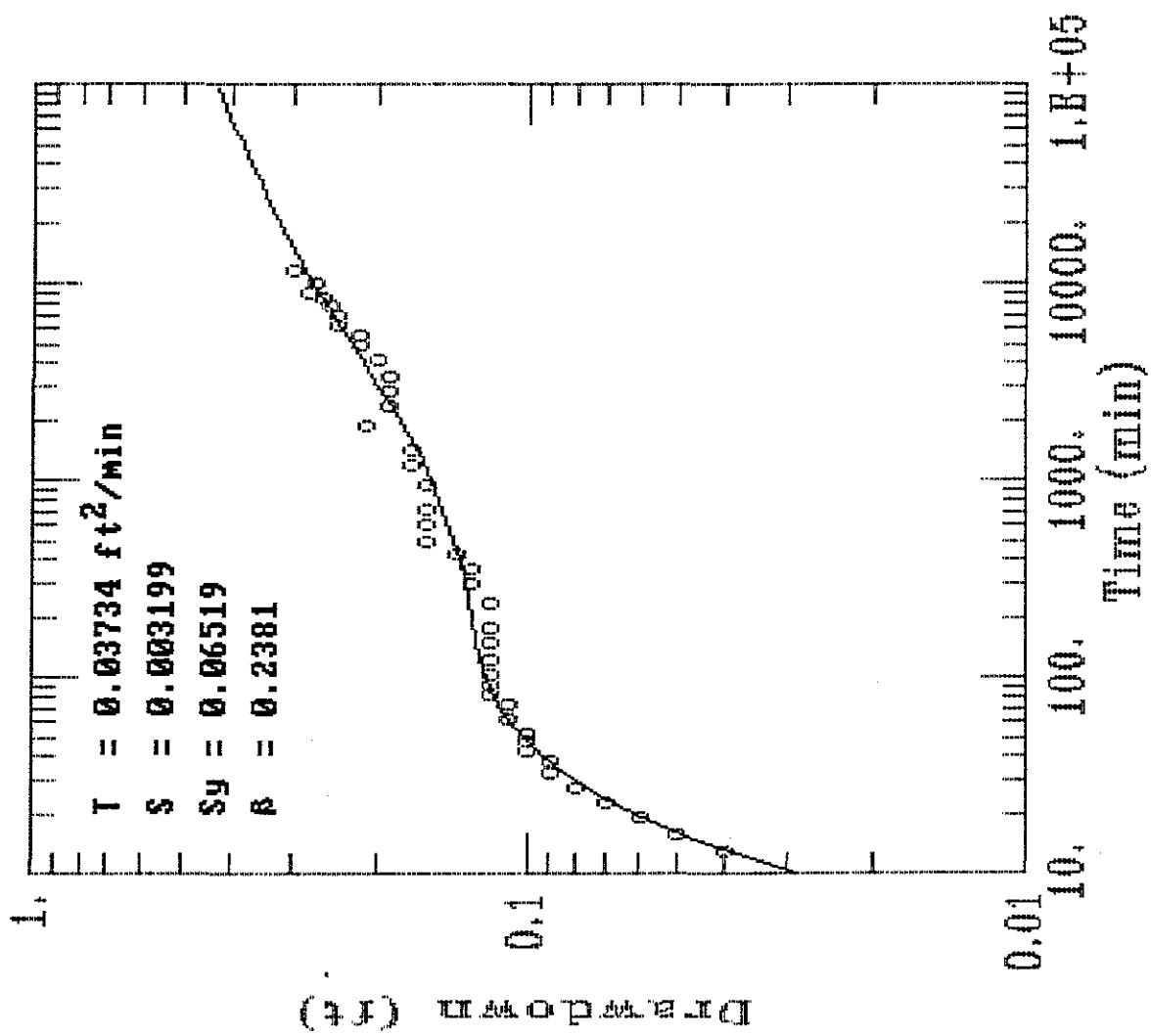


least 58 sec

00259

116 | qZ

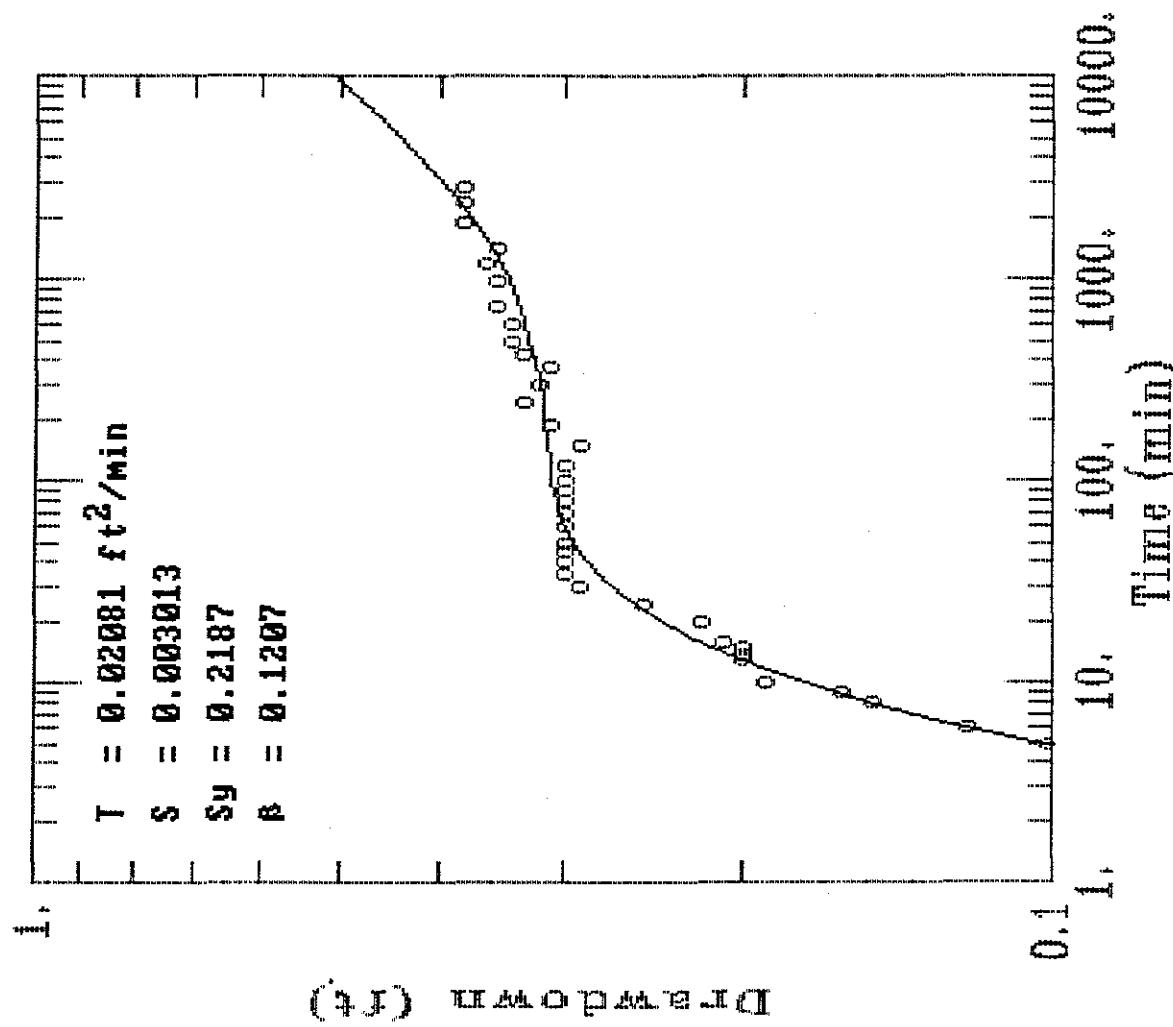
r13



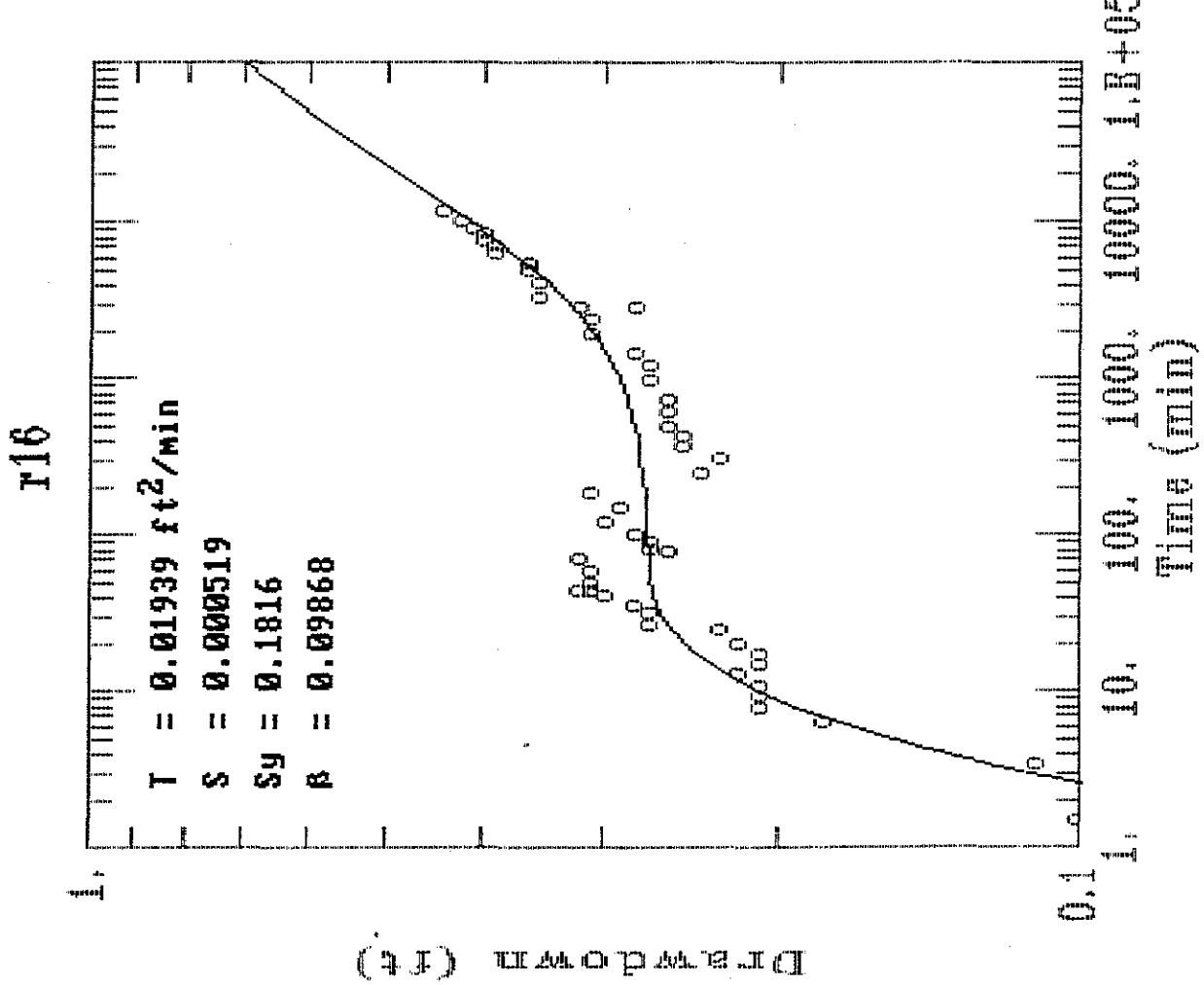
00260

11 16 | 92

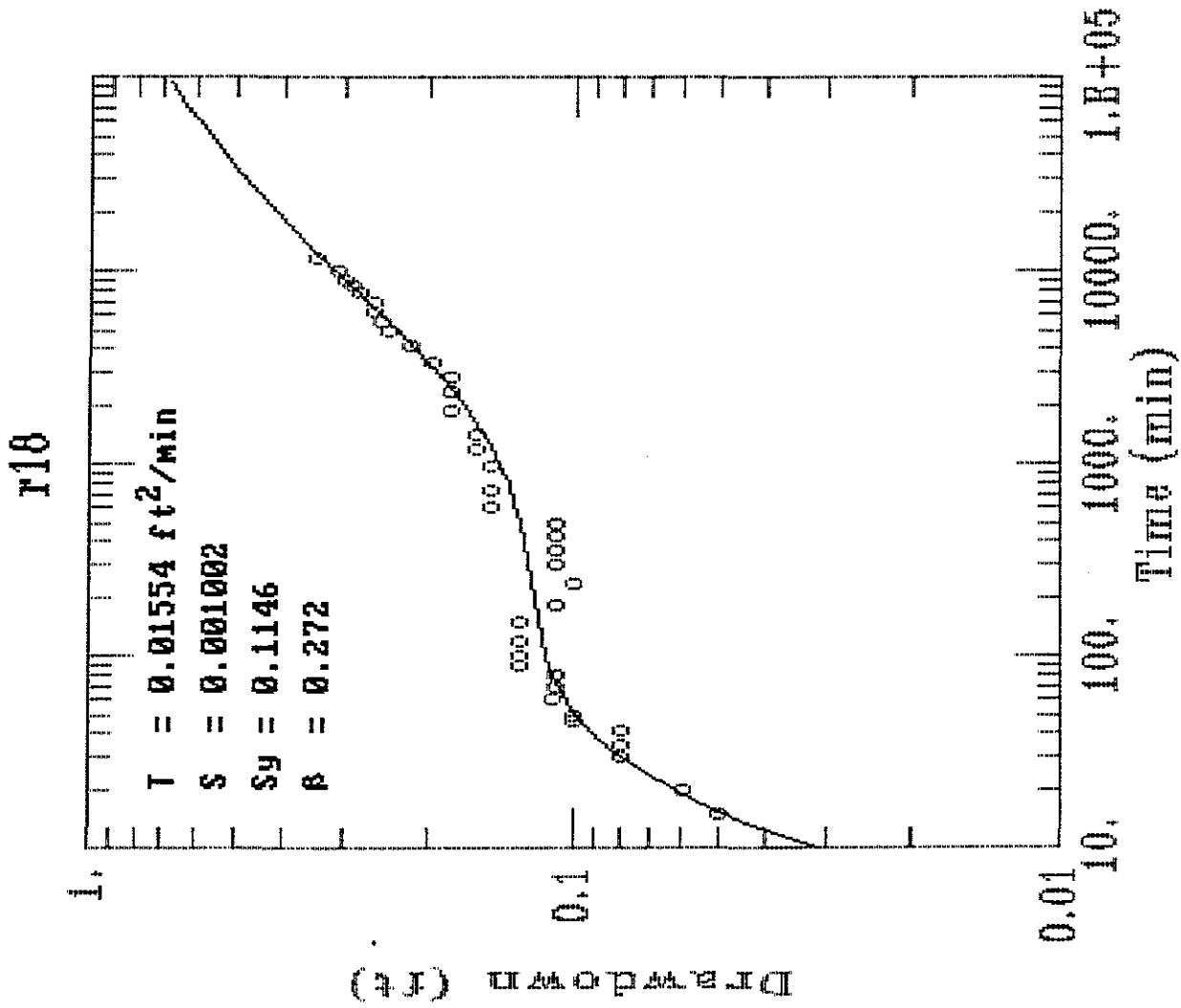
r15



002e1

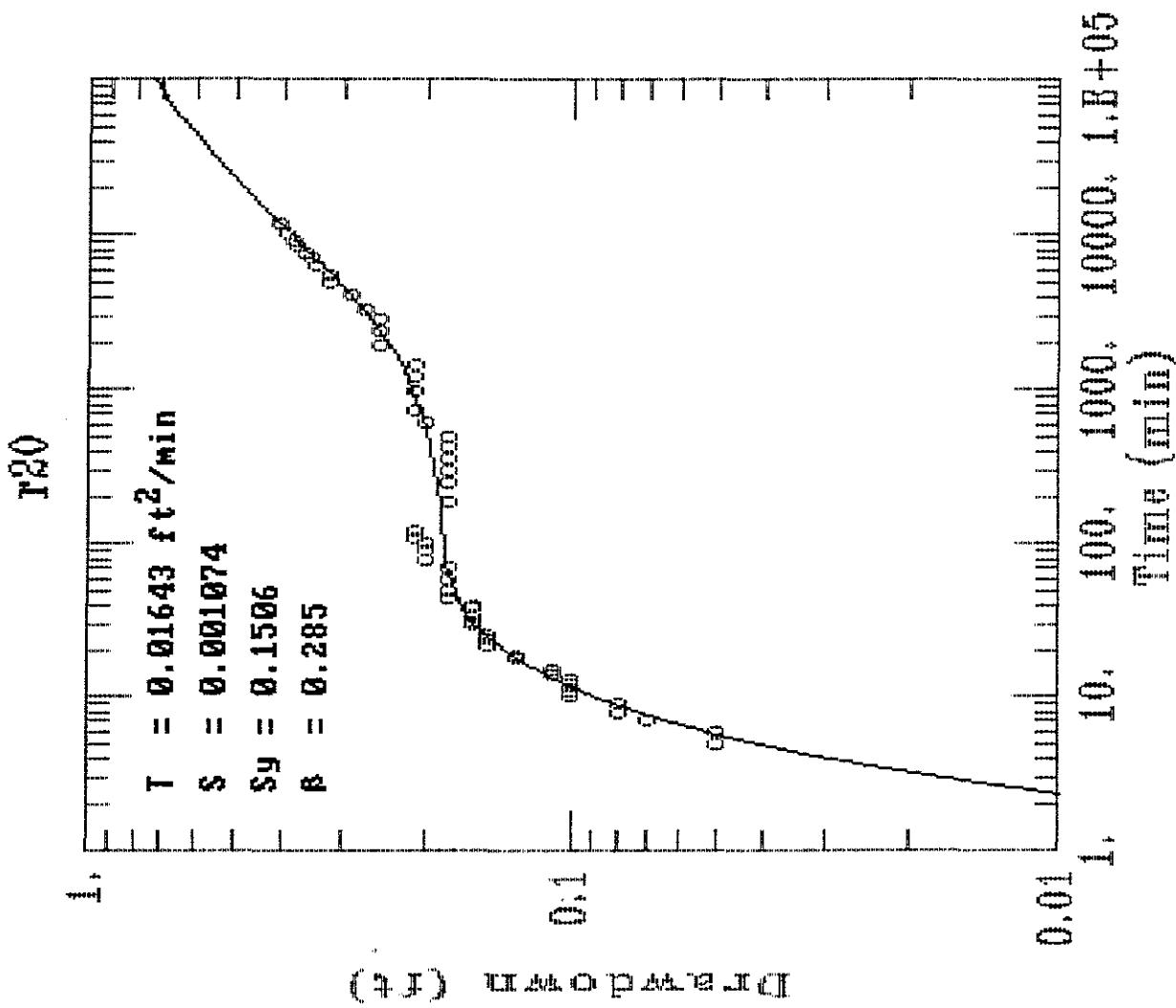


00282



00203

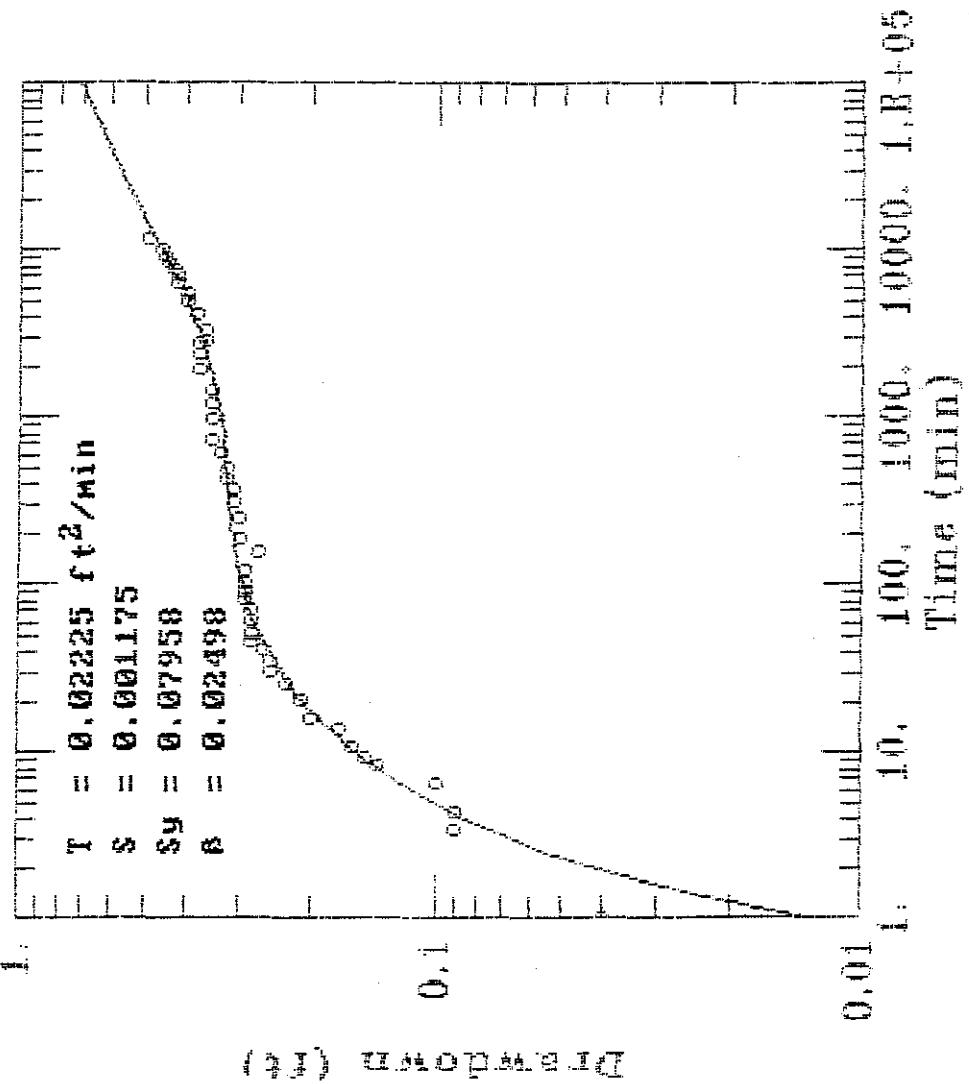
11/17/92



00264

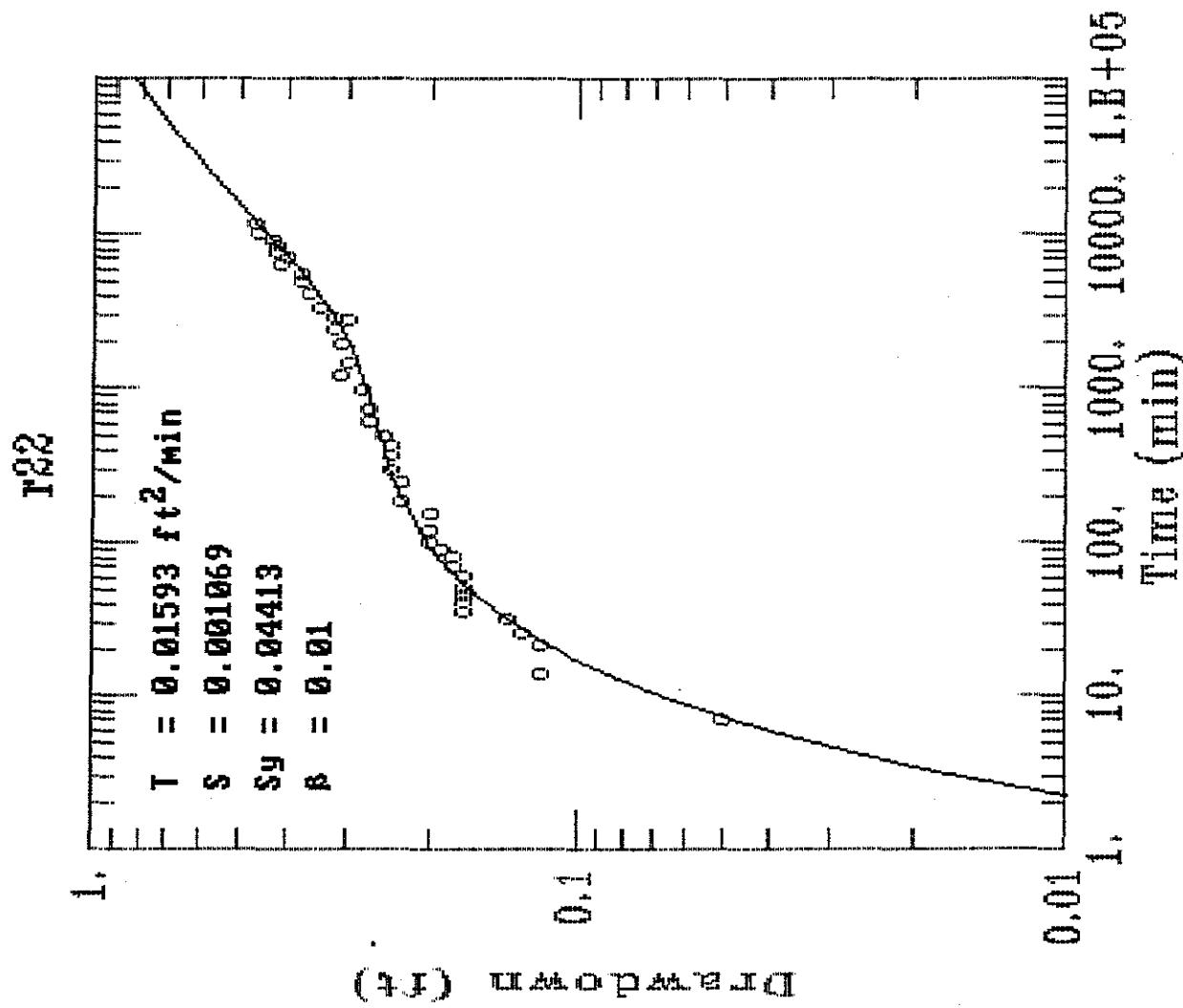
least squares neg.

R-31 Pump Test 1

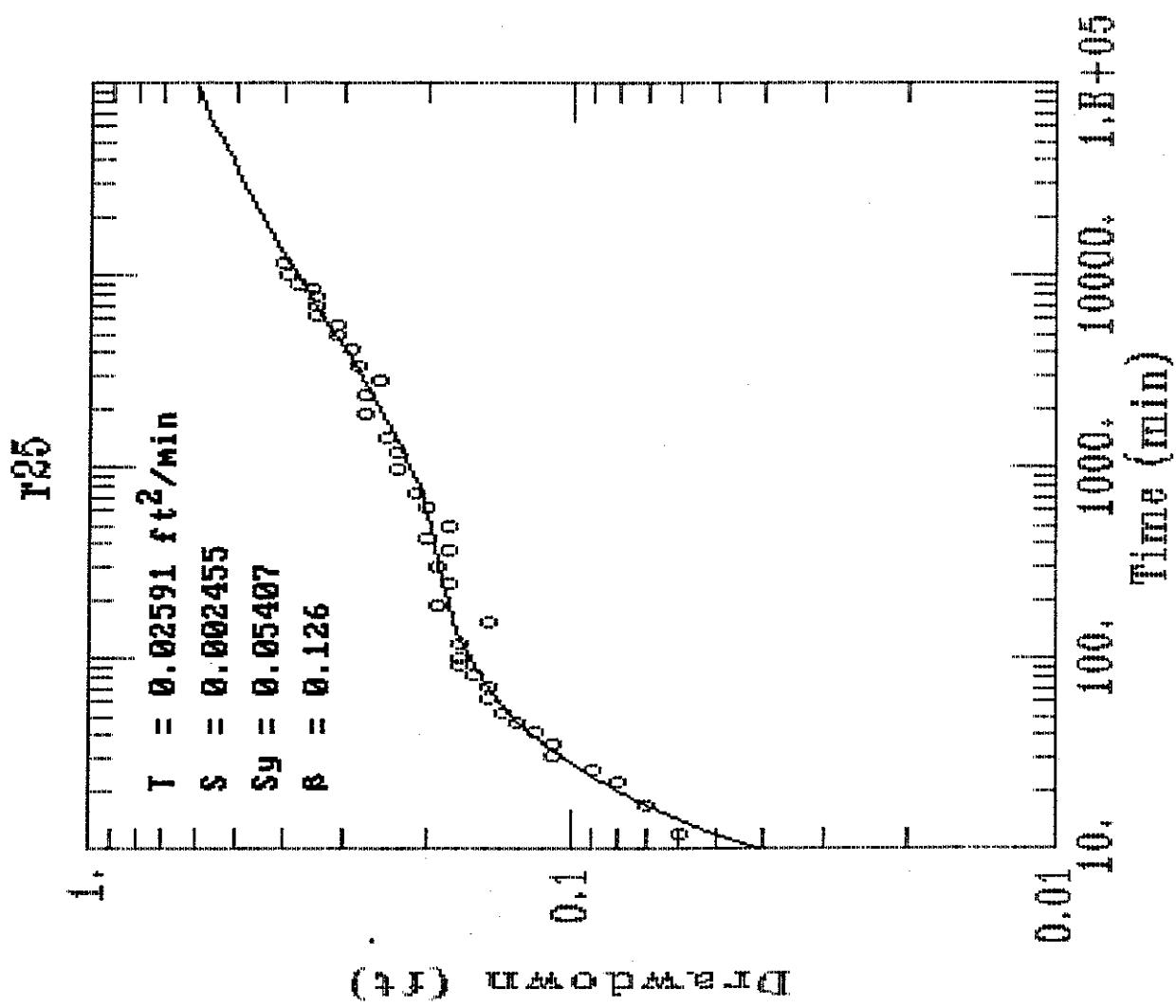


00265

$w/12/r_2$



002e6

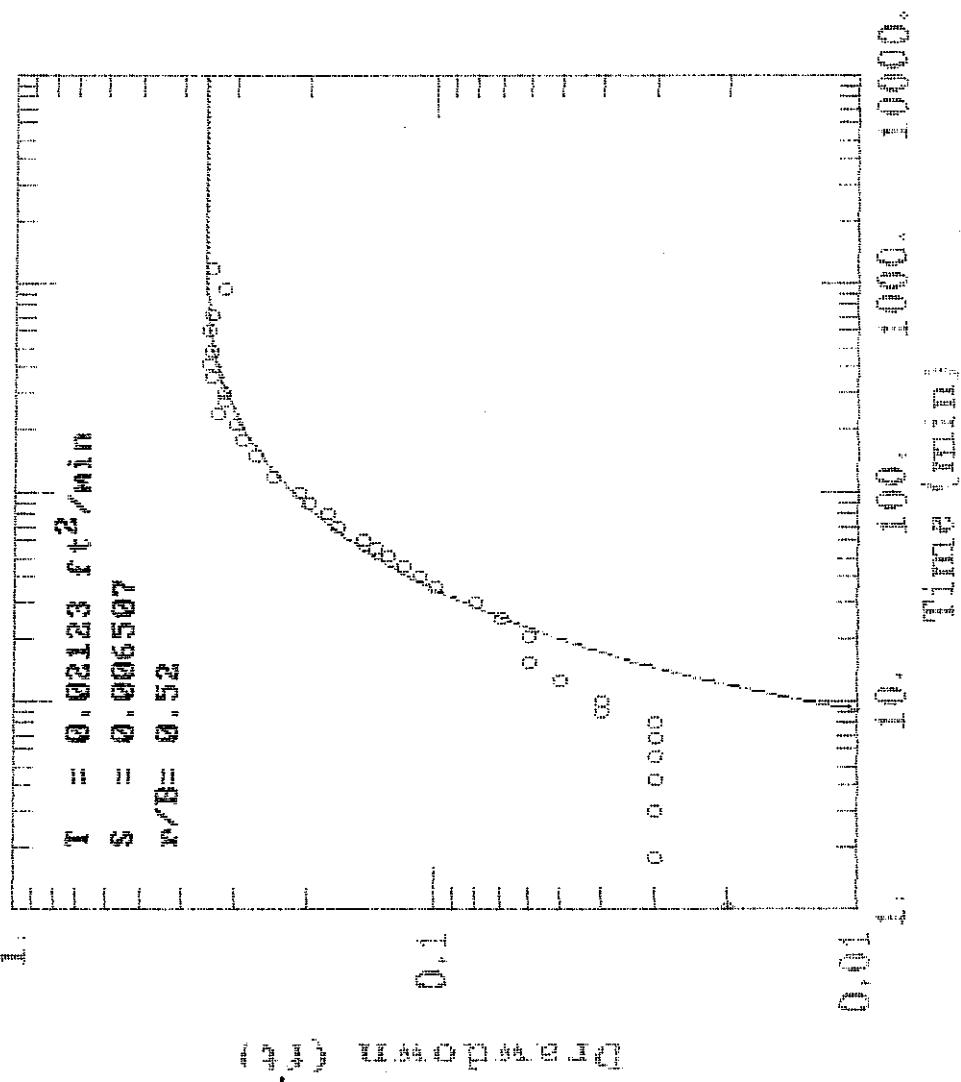


00287

Pumping tests, Hantush method - Site 2

00268

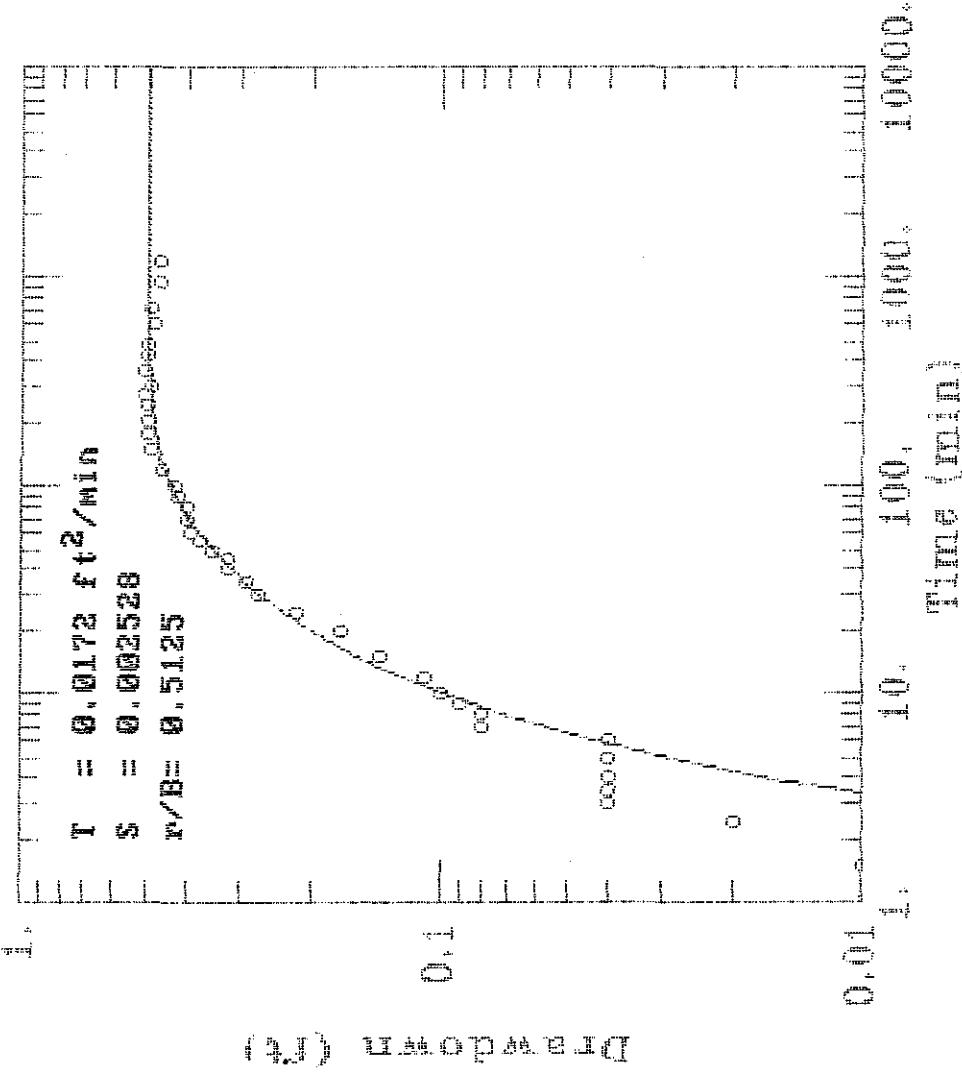
CC-4 Pump Test 1



Hantush
pp.

00269

CC-5 Pump Test 1

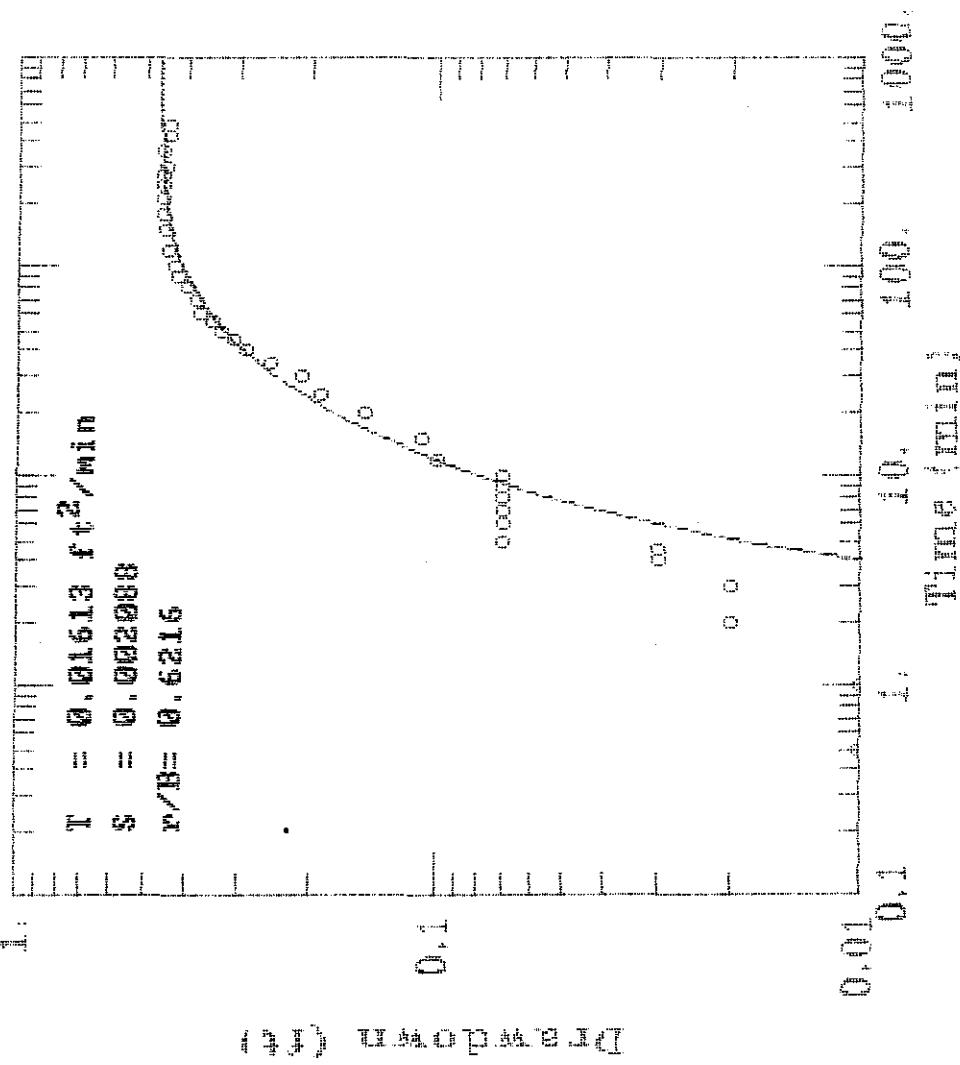


Hankins
P.S.

Hantke

$$\frac{K_y}{K_x} \approx 6.1$$

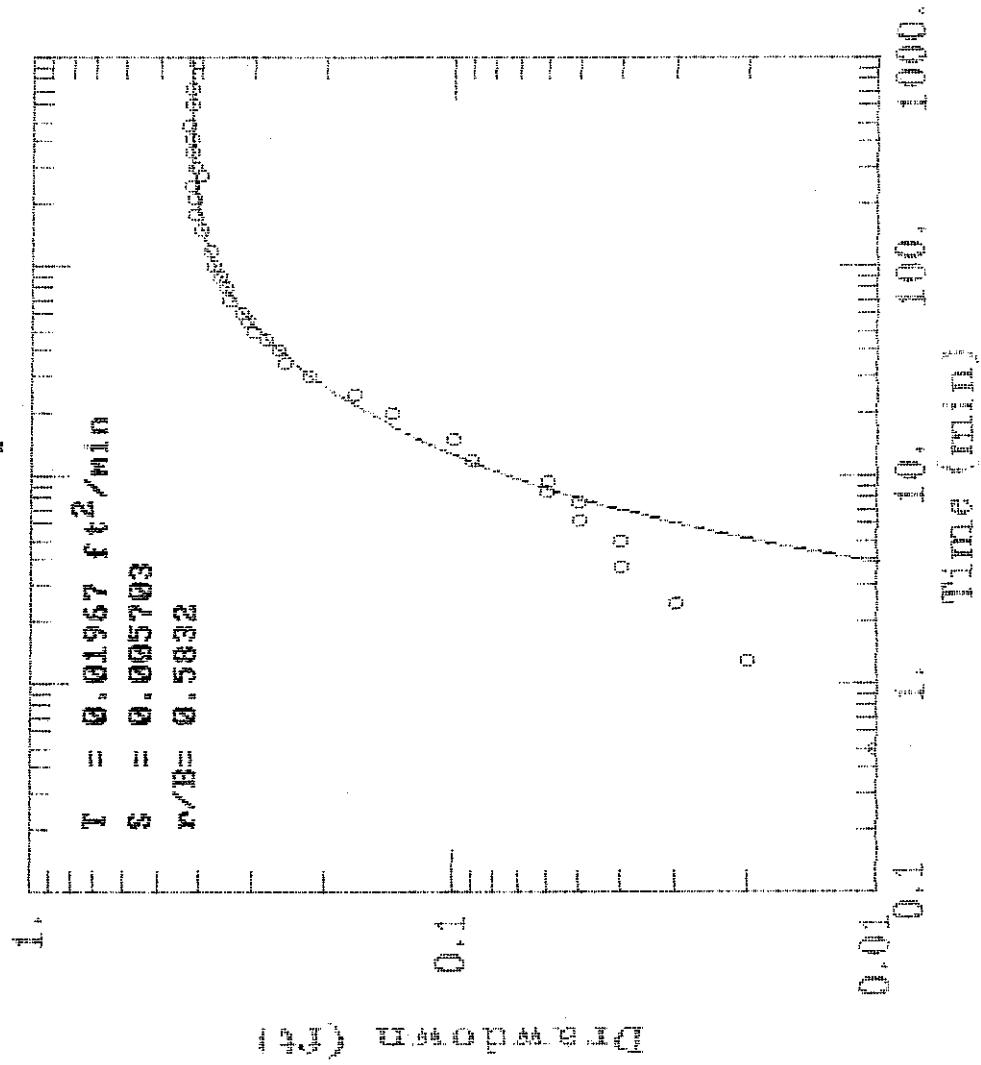
CC-6 Pump Test 1



00270

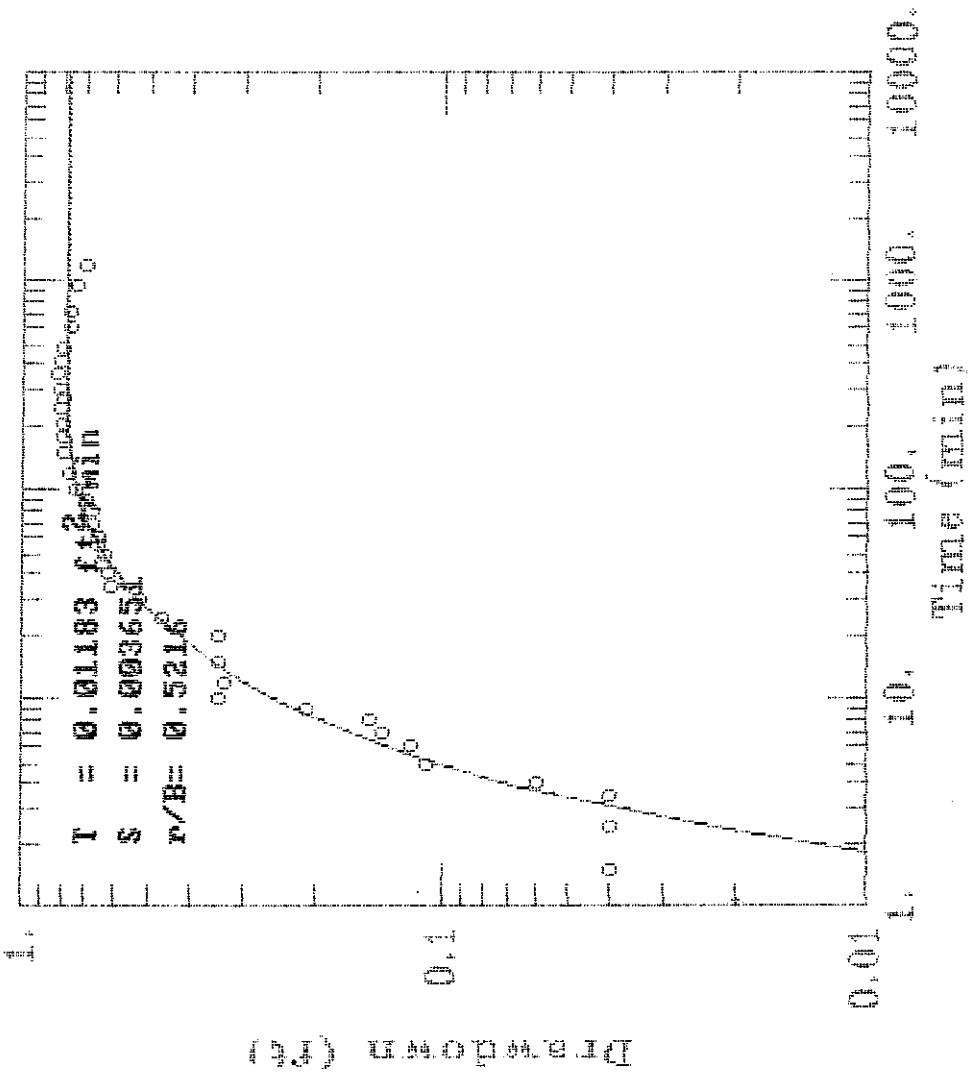
00271

CC- γ Pump Test 1



00272

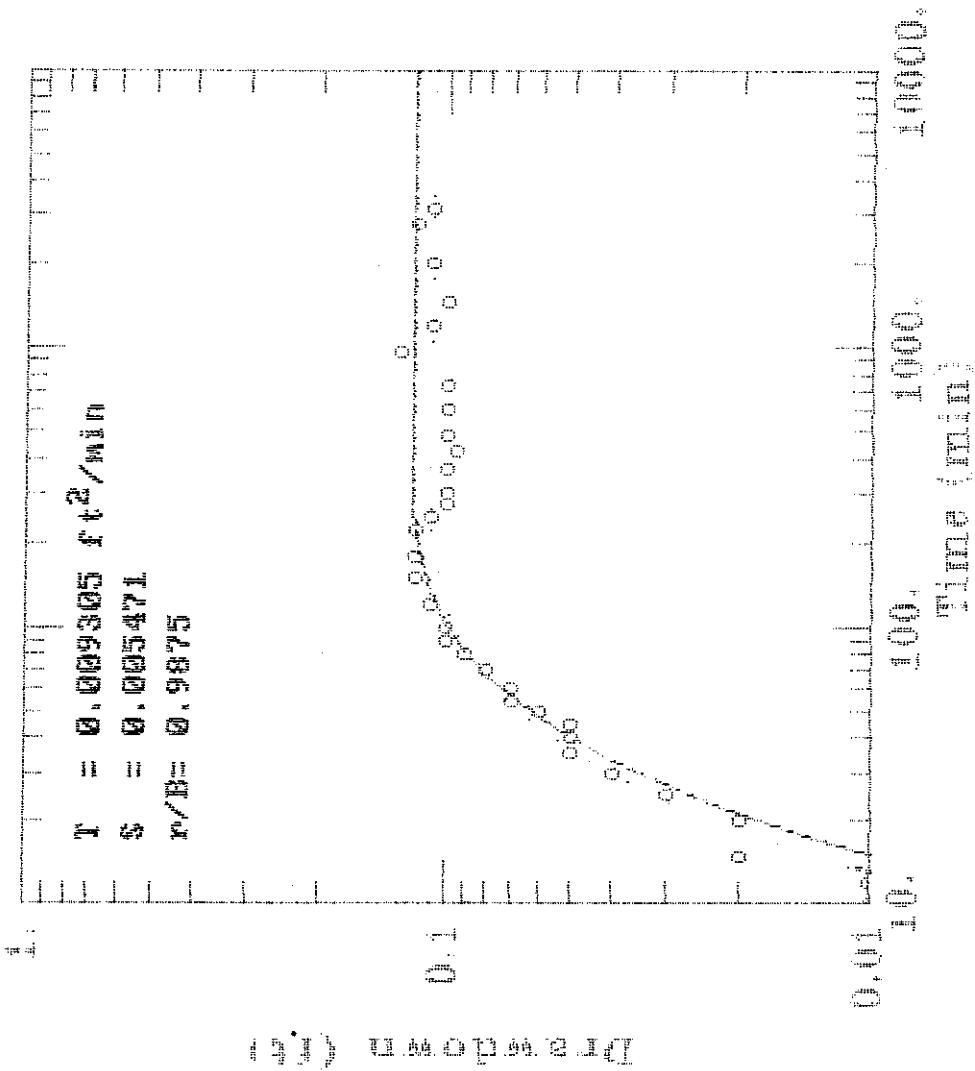
CC-8 Pump Test 1



Plavush

00273

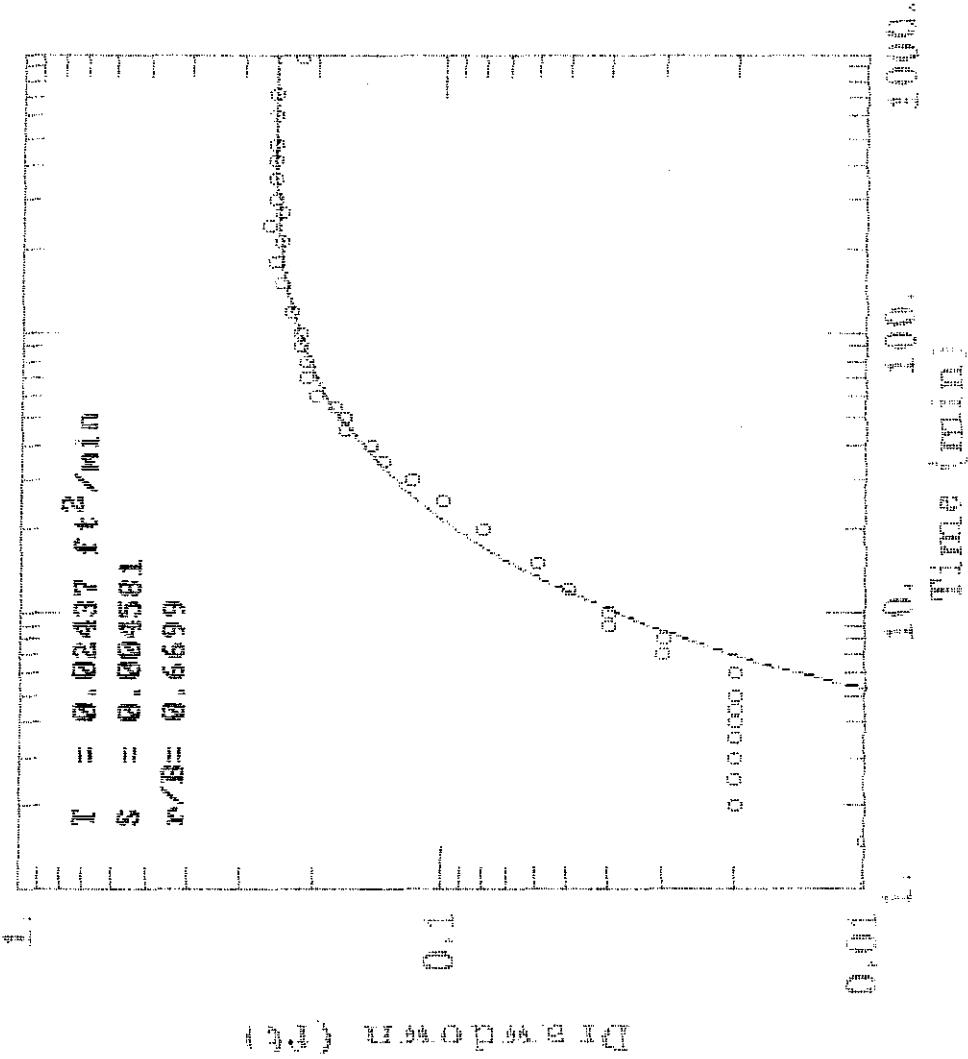
CC-9 Pump Test 1



00274

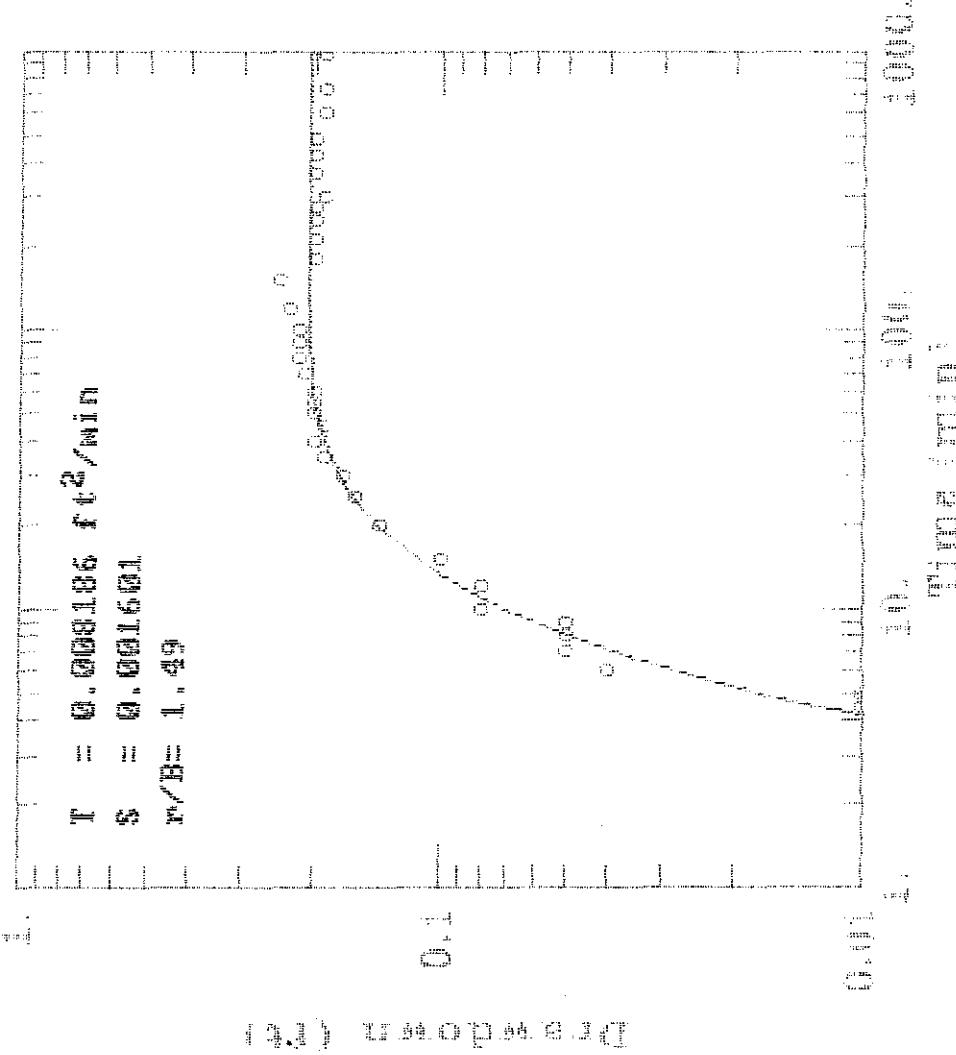
CG-10 Pump Test 1

$$\begin{aligned}T &= 0.02437 \text{ ft}^2/\text{min} \\S &= 0.004381 \\n/R &= 0.6699\end{aligned}$$



00275

CC-11 Pump Test 1



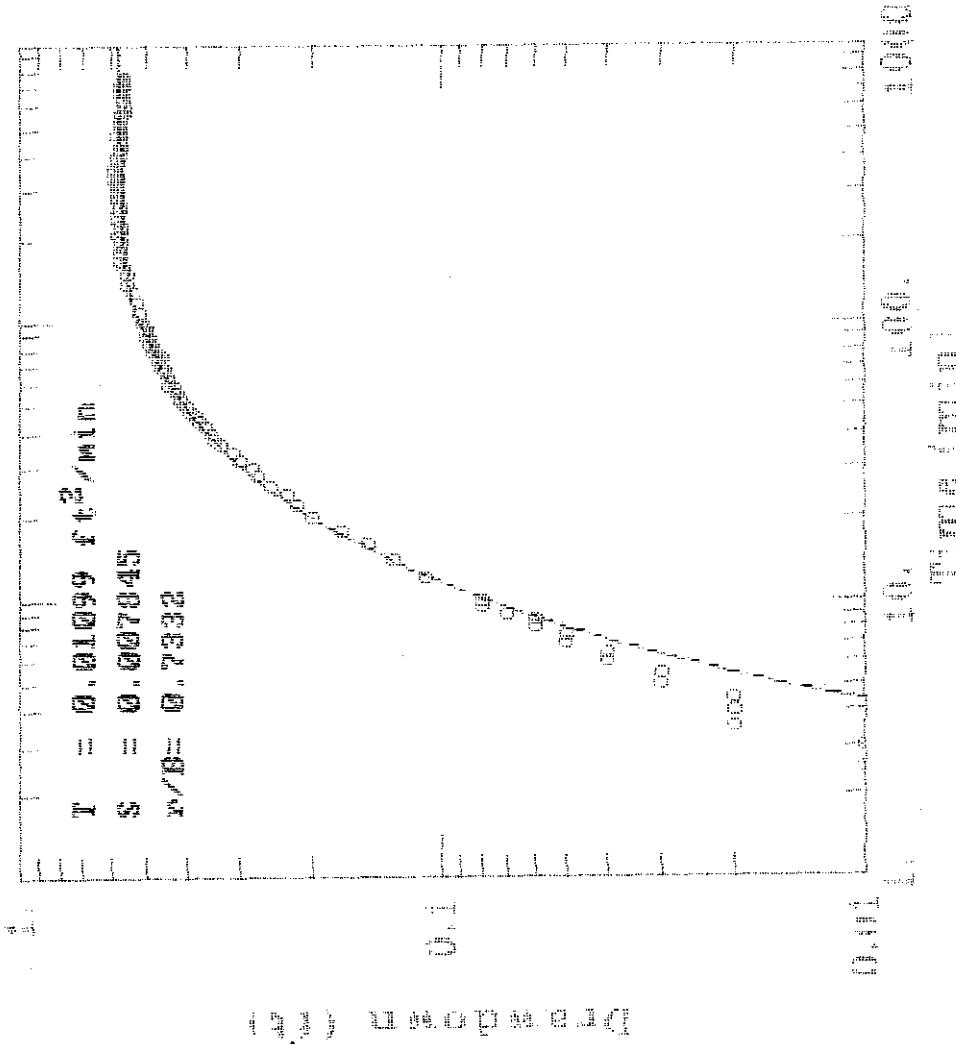
$$T = 0.000136 \text{ ft}^2/\text{min}$$

$$S = 0.001631$$

$$R/B = 1.49$$

00276

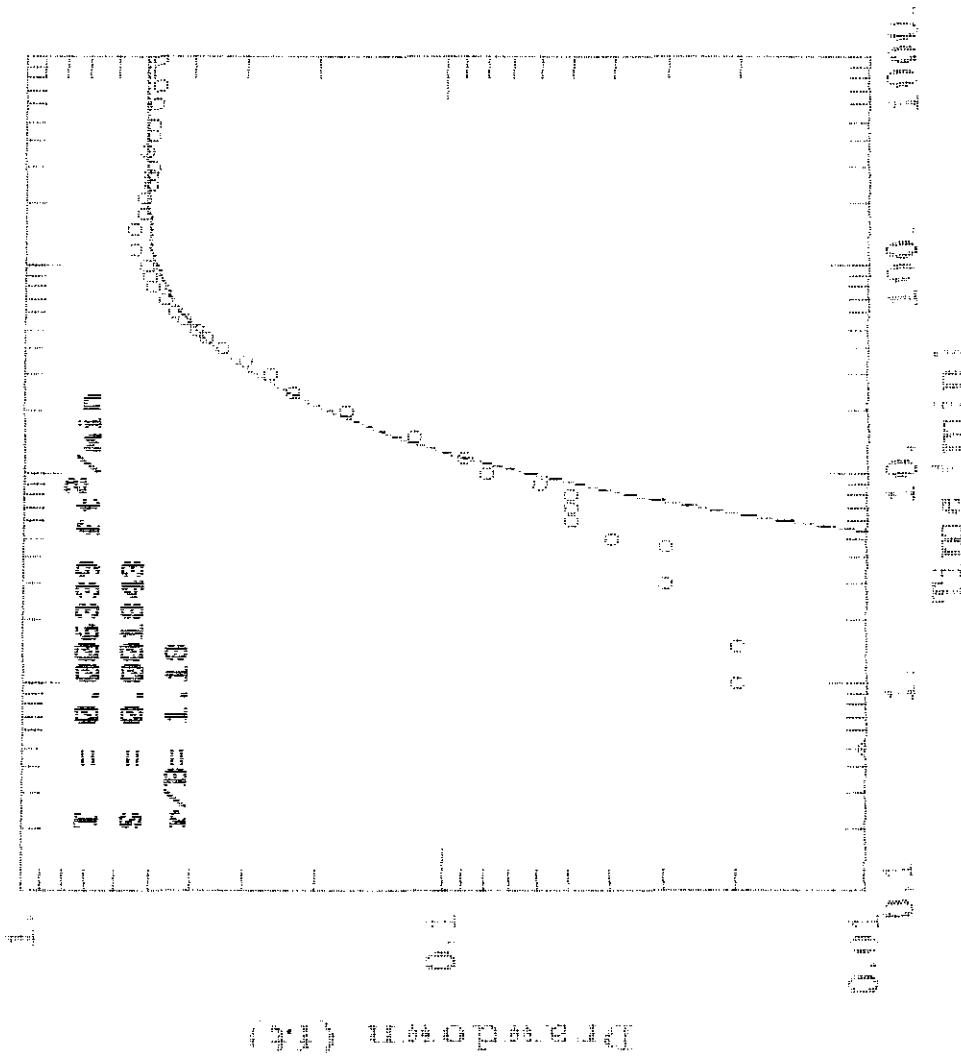
CC-12 Pump Test



Plants
P.M.

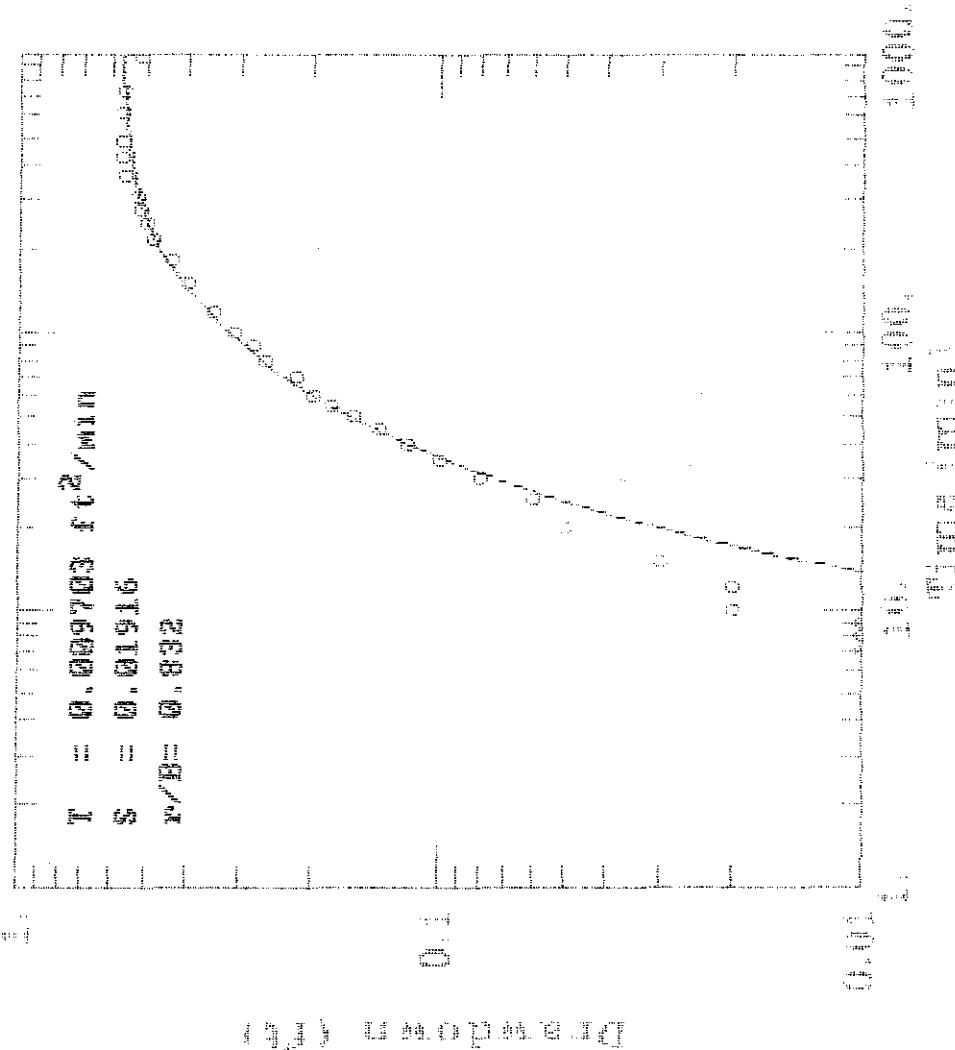
00257

CC-19 Putting Test 1



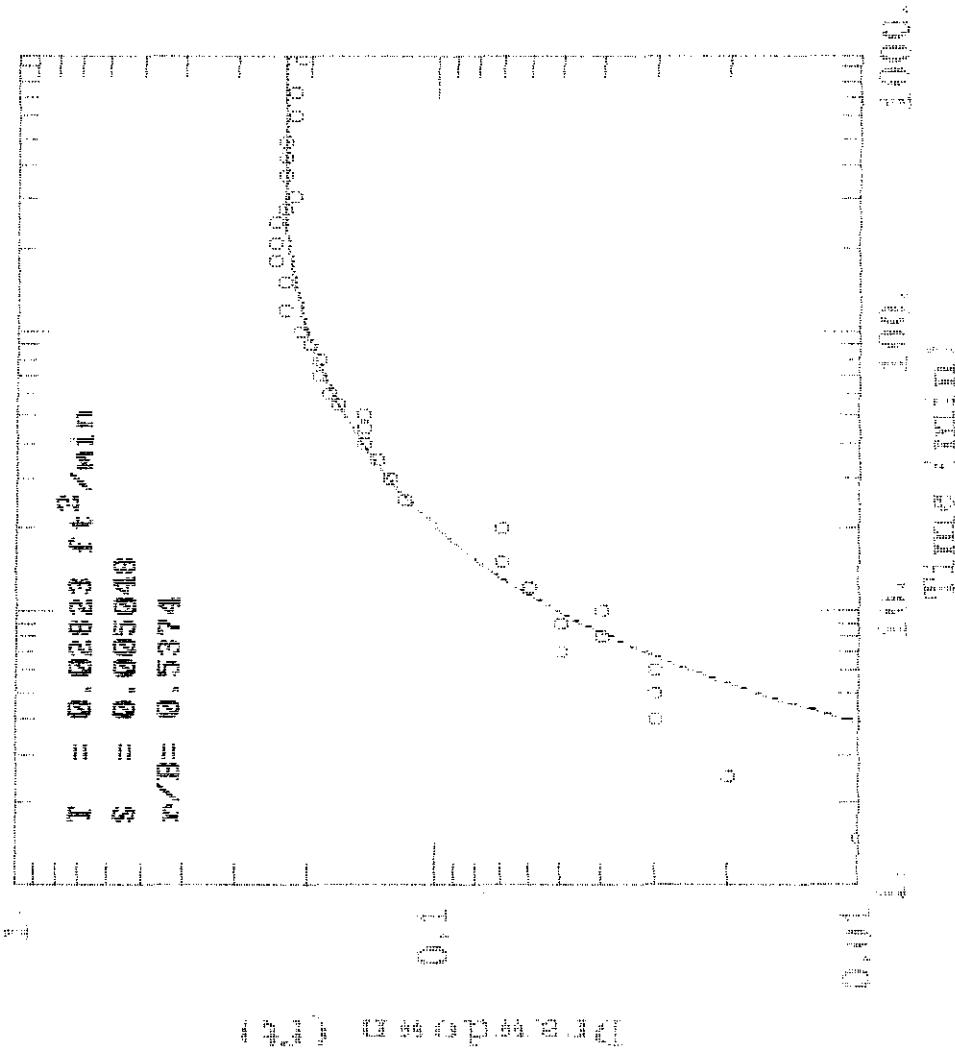
0028

CC-18 Pump Test 1



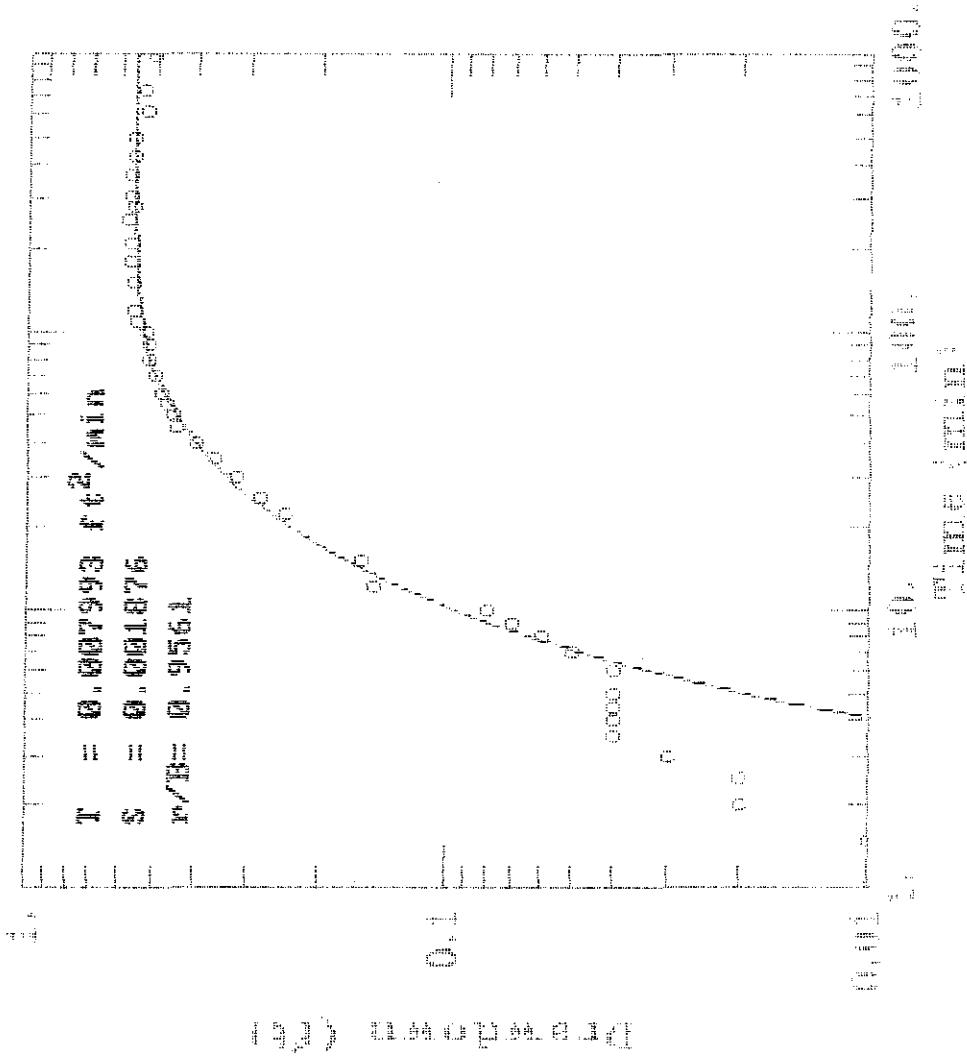
00279

CC-16 Pump Test 1



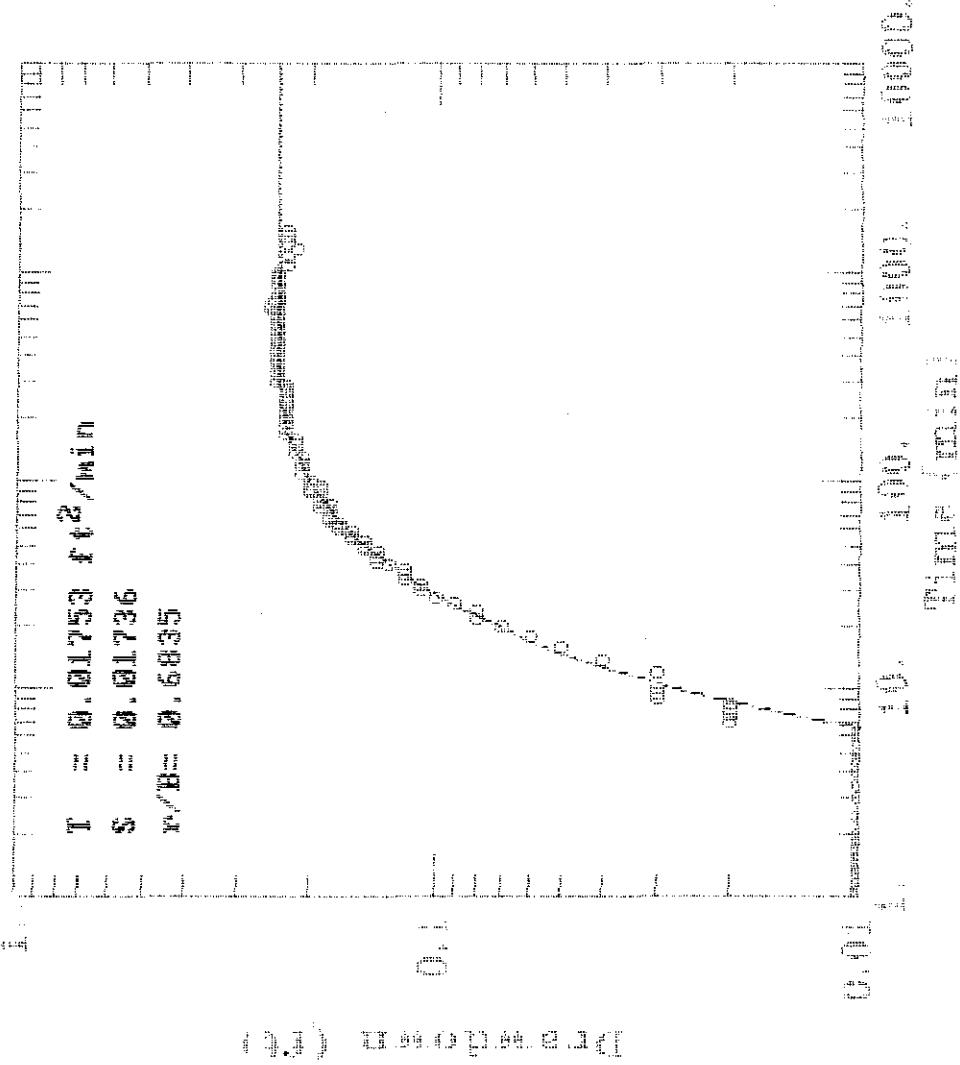
00280

CG-17 Pump Test 1



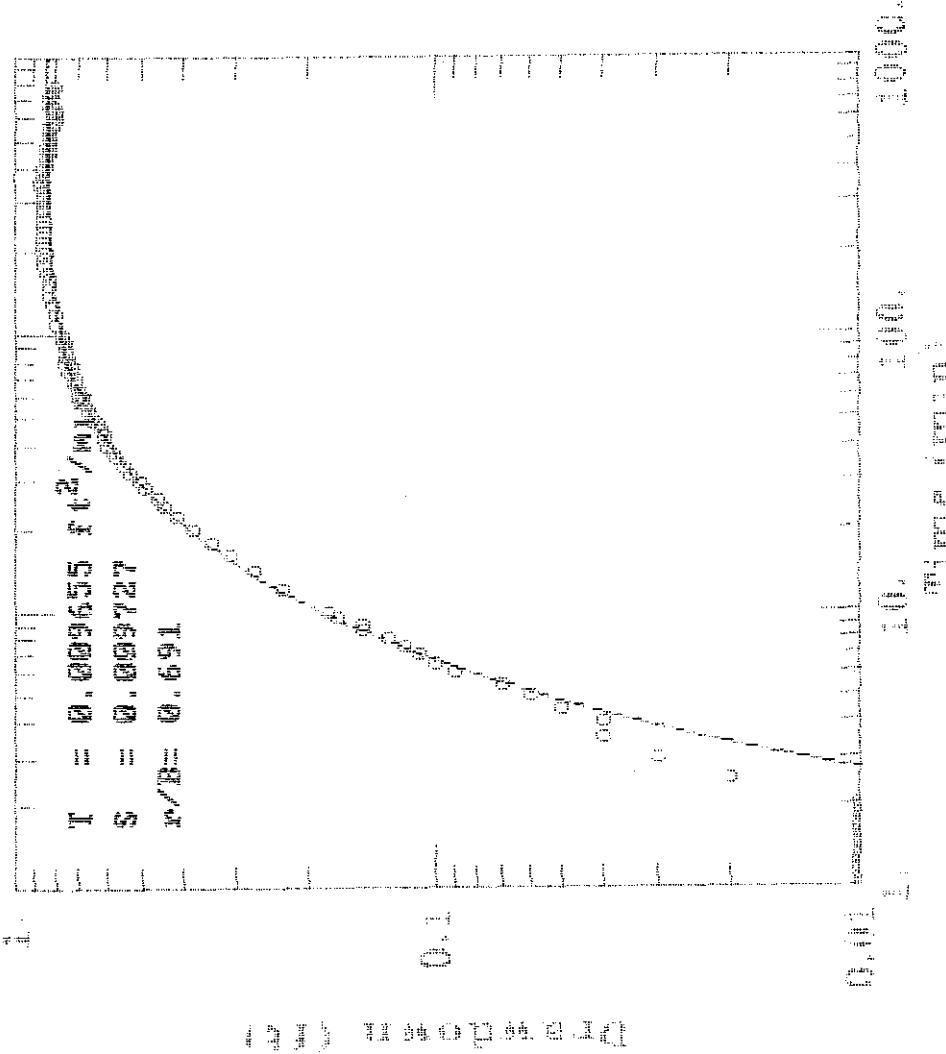
00291

CC-16 Pump Test 1



00282

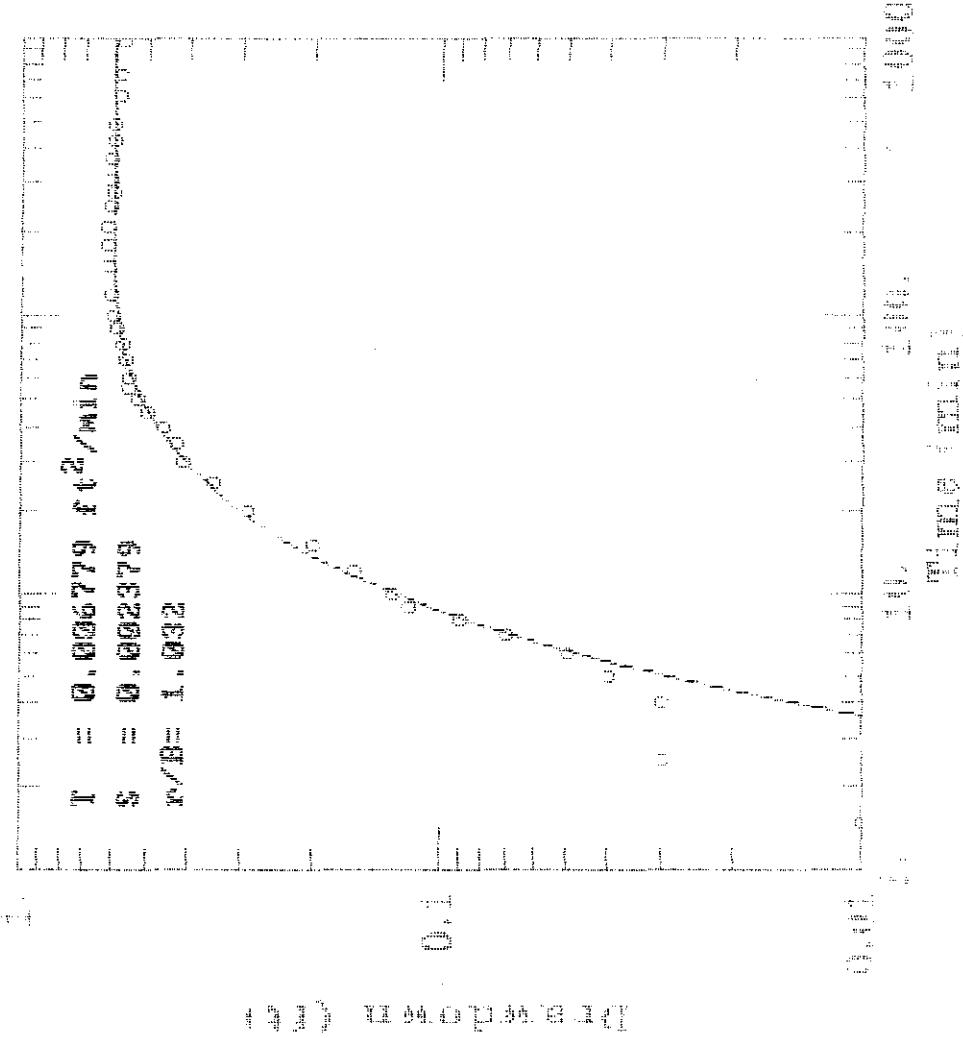
CG-10 Pump Test 1



Plant test

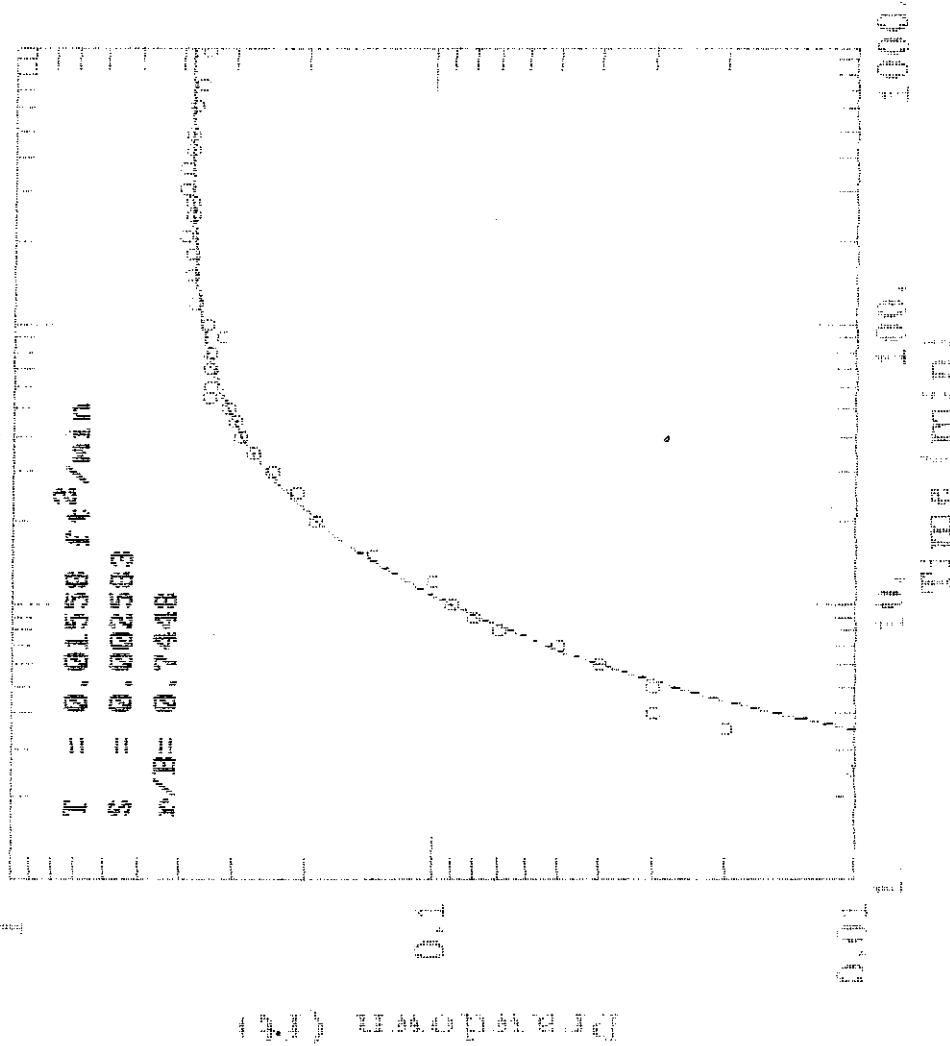
00283

CC-32) PINTA Test 1



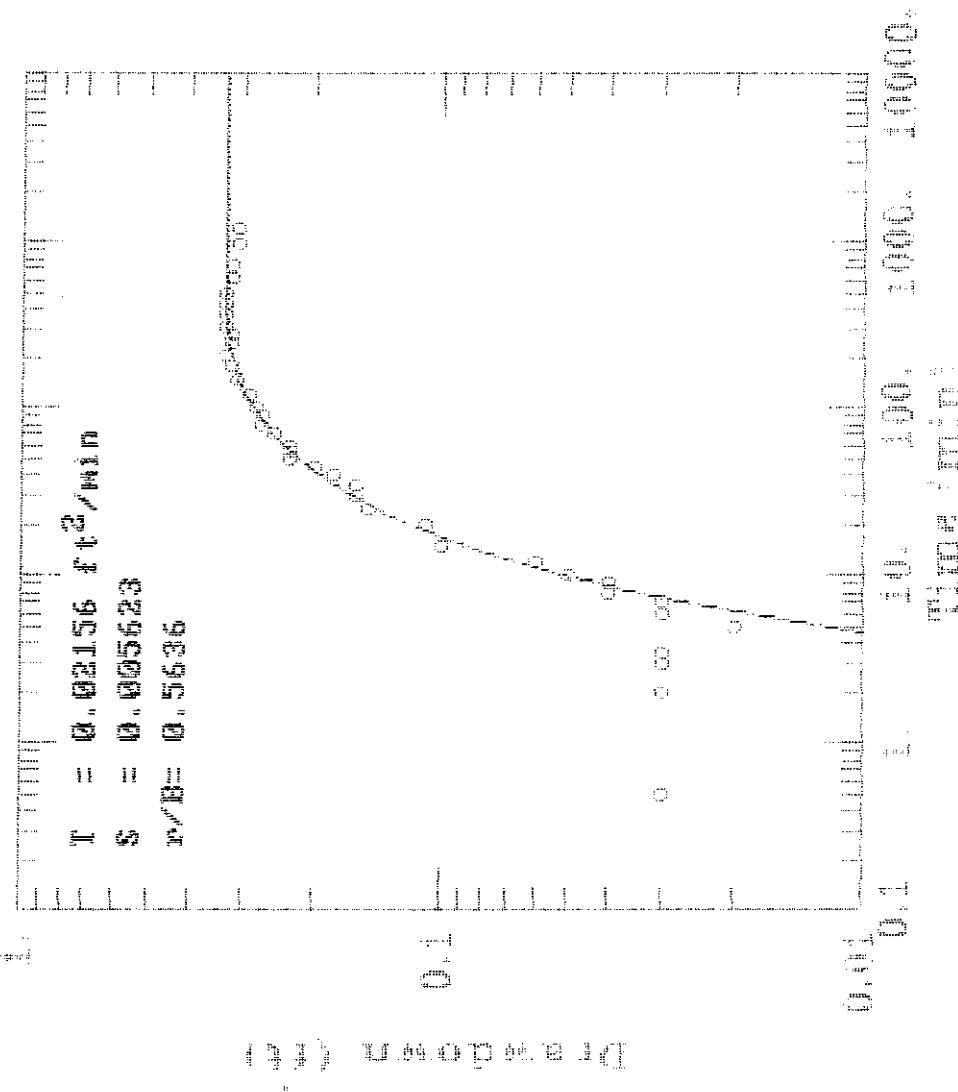
00284

00-32 Pump Test 1



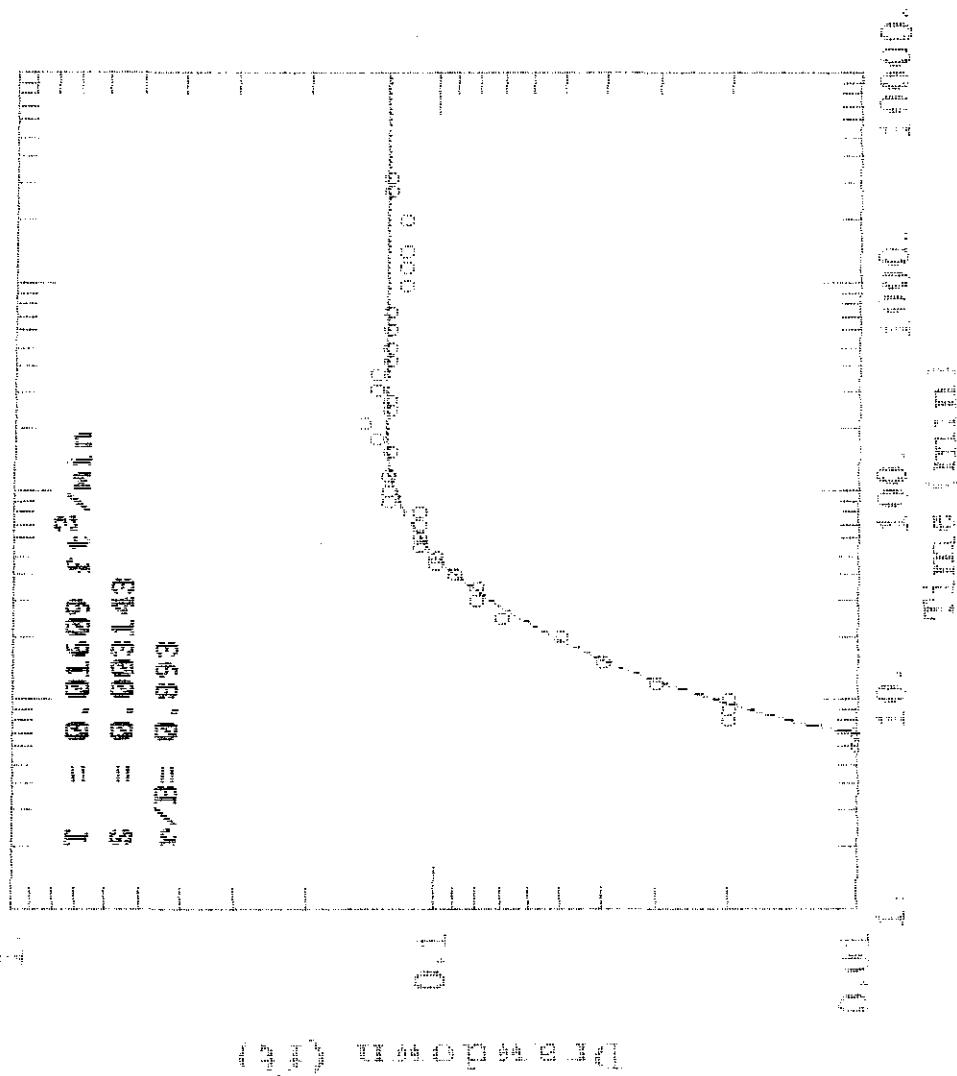
00285

CC-28 Pump Test 1



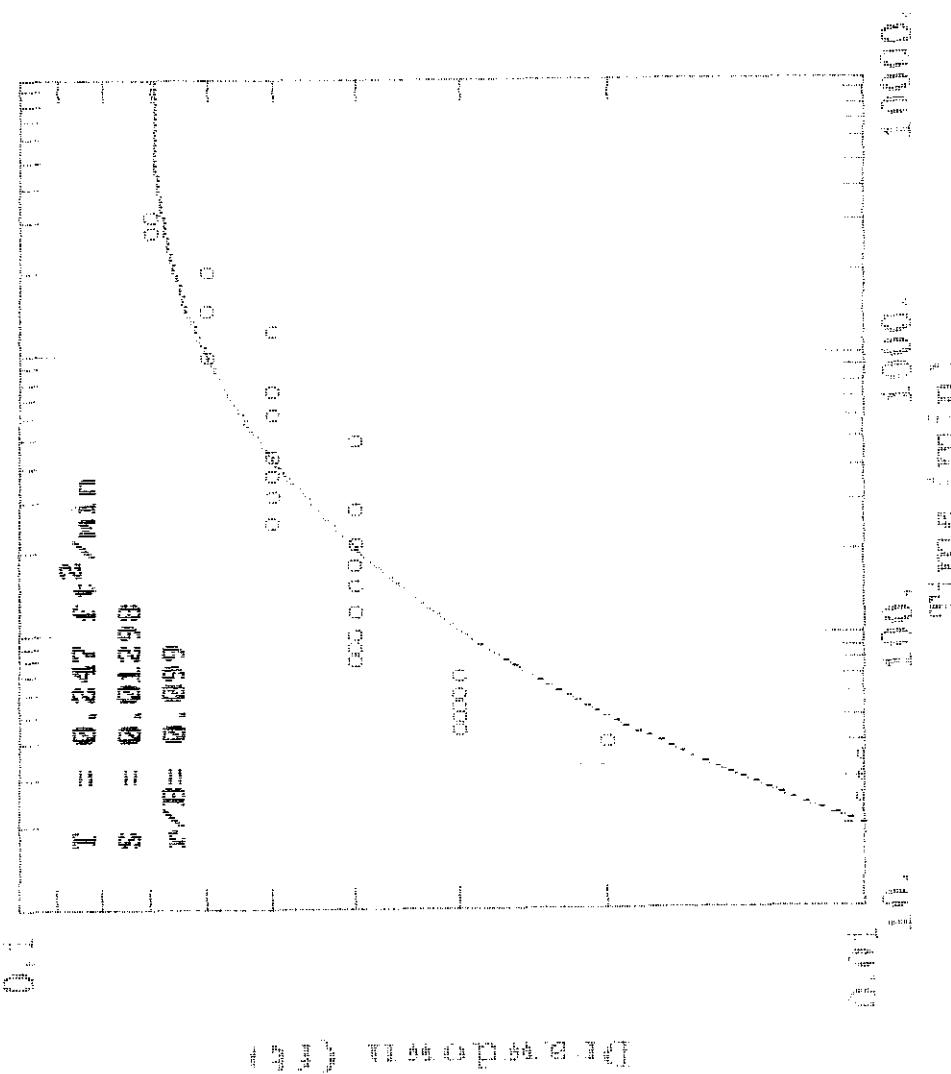
00286

CC-34 Pump Test 1



00287

CC-35 Pump Test 1



00268

CC-36 Printed Test 1.

$$\begin{aligned}T &= 0.01295 \text{ sec/min} \\S &= 0.005001 \\k'/\theta &= 1.335\end{aligned}$$

