Well Test Interpretation

SKM4323

THE DERIVATIVE

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WEEK 07

Introduction

- Methods using the pressure derivative take advantage of the advantages of the type curve representation and counteract the drawbacks of the logarithmic representation.
- These methods are based on an observed fact: in a well test the pressure variation is more significant than the pressure itself.
- This is illustrated by the fact that it is the slope of the semi-log straight lines that is used to get information on the reservoir in conventional methods.
- D. Bourdet's approach were proposed in oil industry literature in the early eighties.

D. Bourdet's Approach

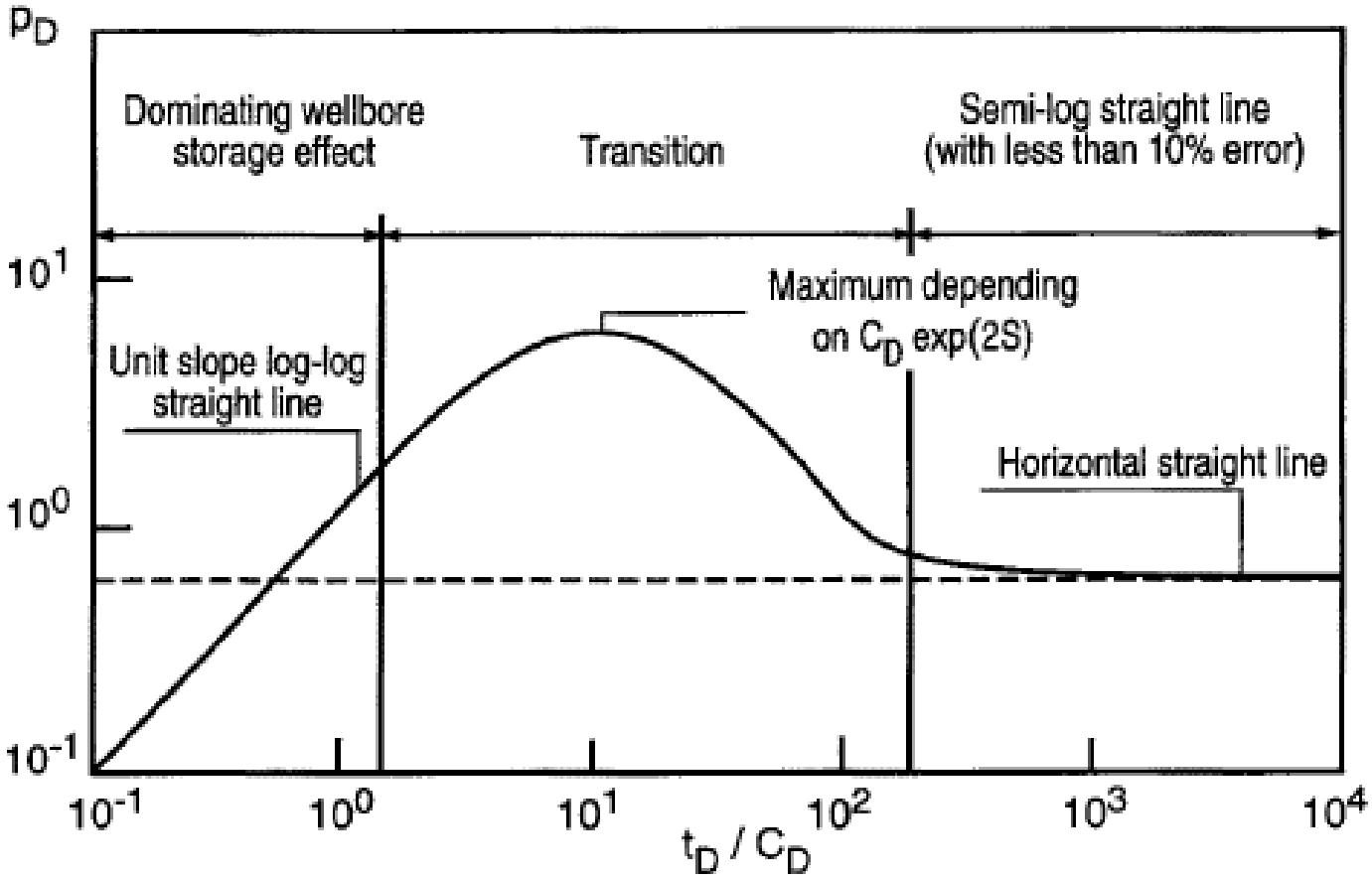

Fig. 6.1

D. Bourdet's Approach…/2

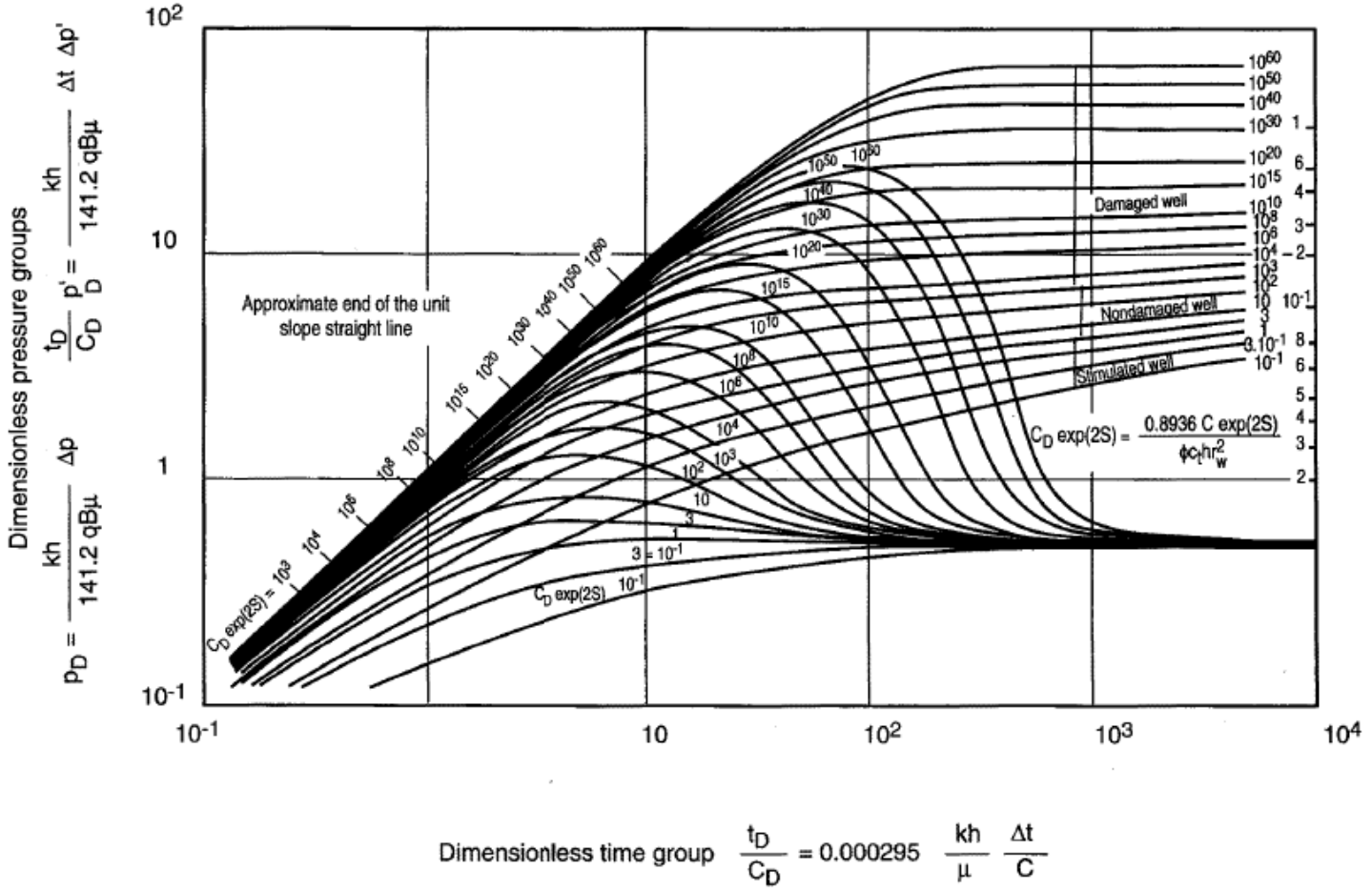

Fig. 6.2 Type curves for a well with wellbore storage and skin (infinite acting homogeneous reservoir)

D. Bourdet's Approach…/3

Procedure

- Plot the measured field data points and their derivative, $\Delta t(d\Delta p/d\Delta t)$, simultaneously on tracing paper using the scale provided by the type curves.
- Look for a type curve to match the field data.
- Note the $C_D \exp(2S)$ value of the type curve matching the data best.
- Pick a match point in both the type curve coordinate system and the data system.
- Analyze.

D. Bourdet's Approach…/4

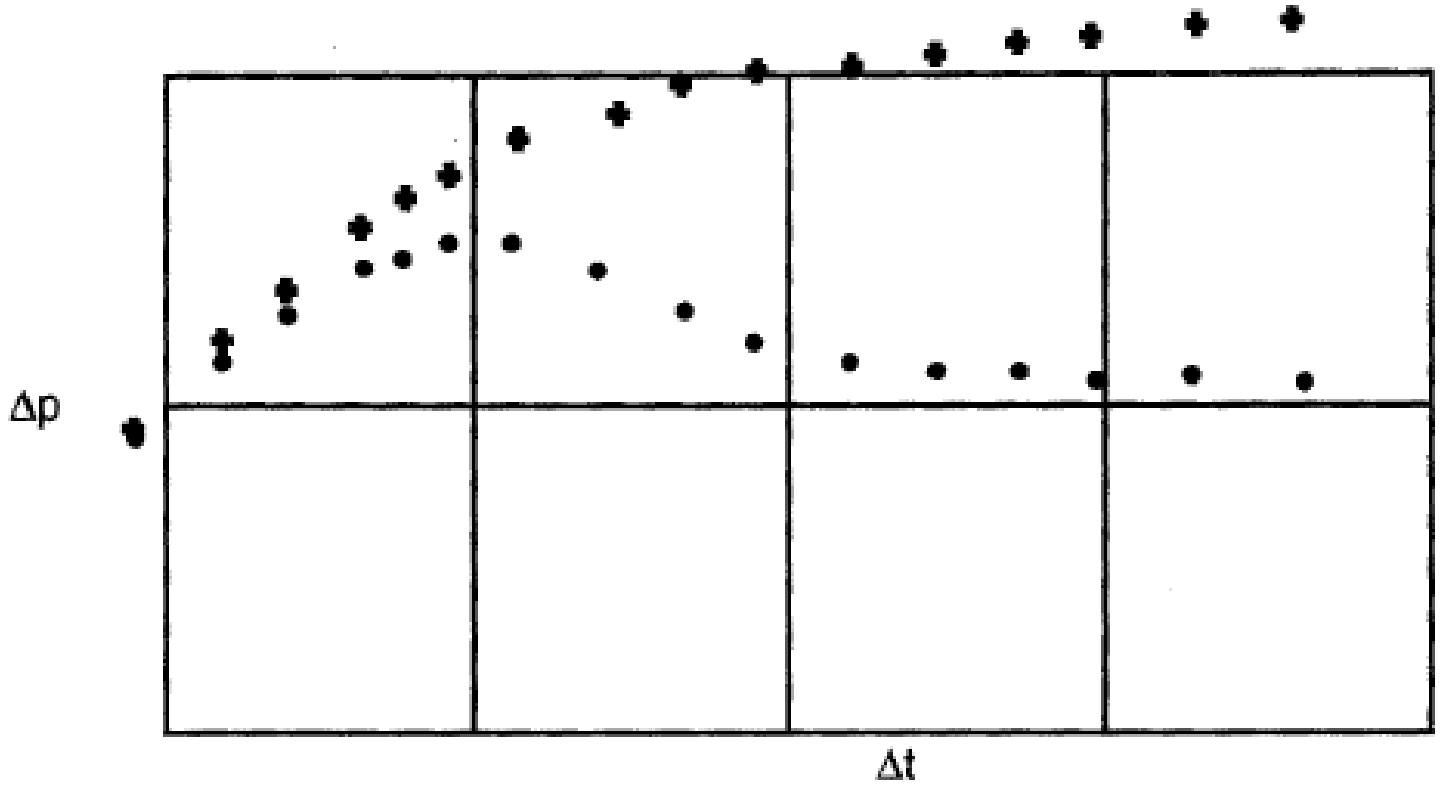

Fig. 6.3a Interpretation with the derivative

D. Bourdet's Approach…/5

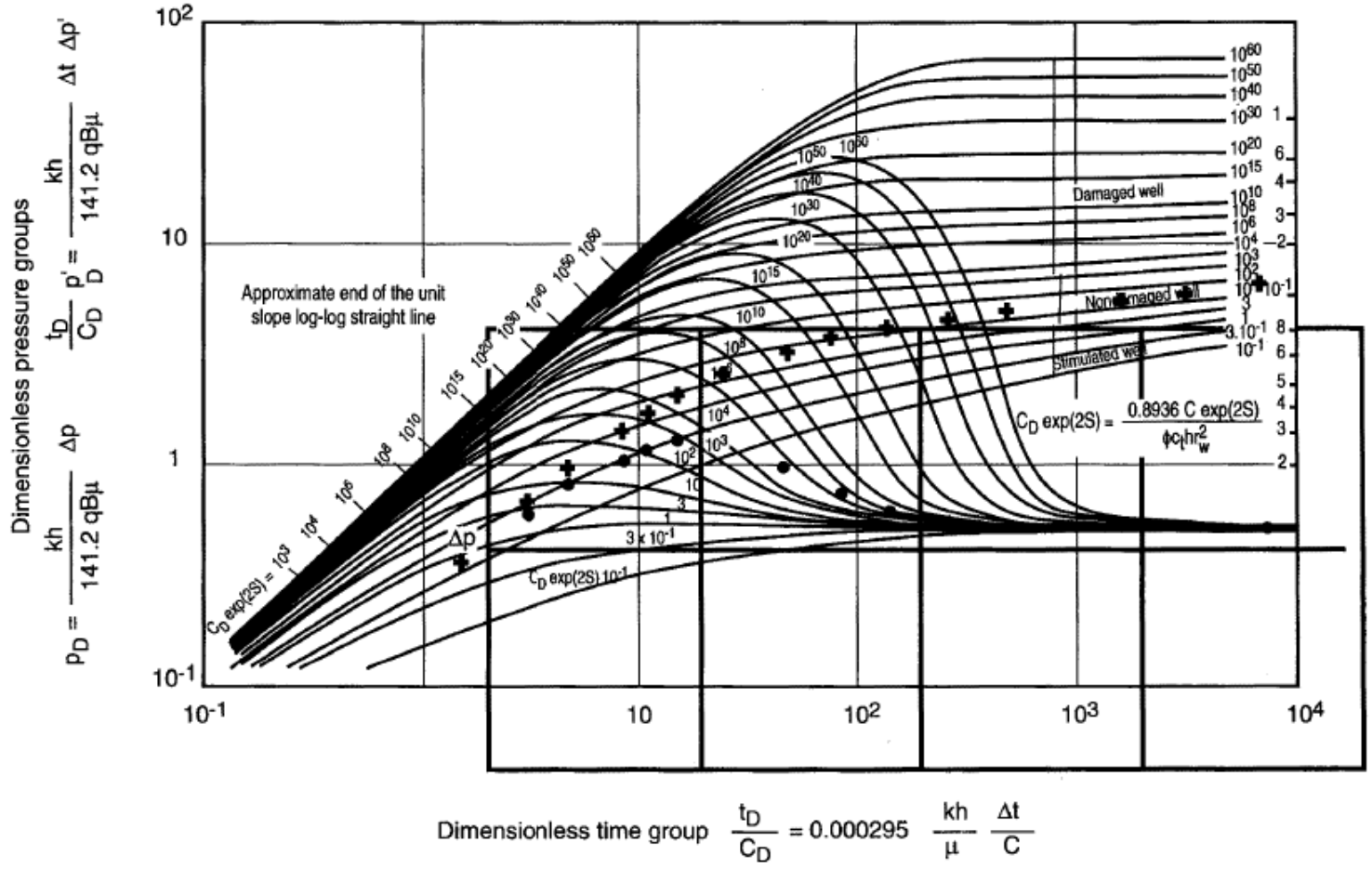

Fig. 6.3b Vertical matching
Type curves for a well with wellbore storage and skin (infinite acting homogeneous reservoir)

D. Bourdet's Approach…/6

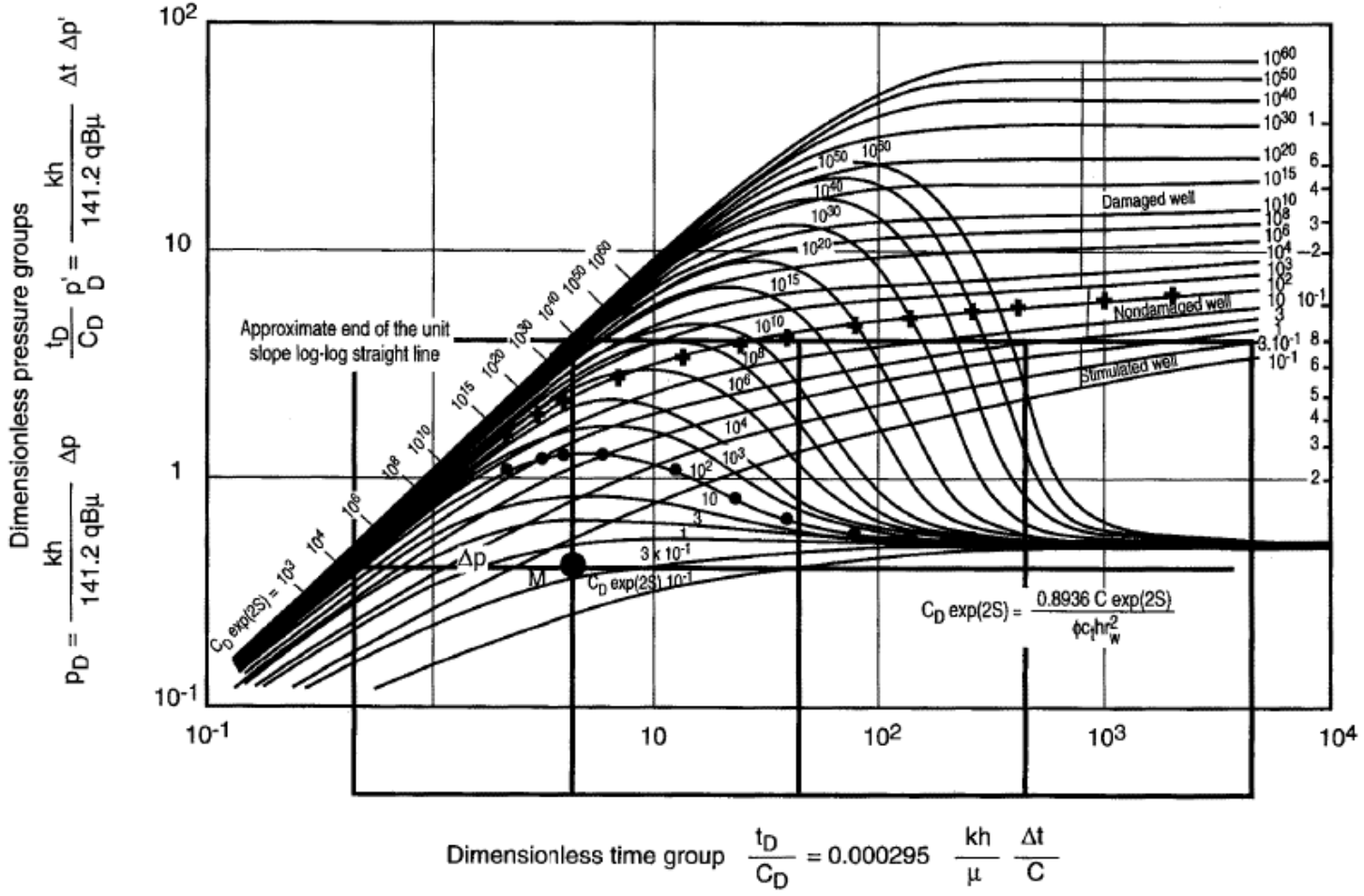

Fig. 6.3c Vertical + horizontal matching
Type curves for a well with well storage and skin (infinite homogeneous reservoir behavior)

D. Bourdet's Approach…/7

- The points of the derivative of radial flow measurements correspond to a horizontal straight line. The points are matched on the 0.5 ordinate horizontal straight line on the set of curves.
- The points of the derivative of wellbore storage effect measurements are located on a slope 1 straight line. They are matched on the slope 1 straight line passing through the origin of the coordinates on the set of type curves.

Example 8

(In-class workshop)

- Drawdown -

Example 9

(In-class workshop)

- Buildup-

Direct interpretation

- Permeability is calculated based on the value $\Delta p'_{st}$ corresponding to the stabilization of the derivative.
- The value of this derivative expressed in dimensionless terms is known, it is equal to 0.5.

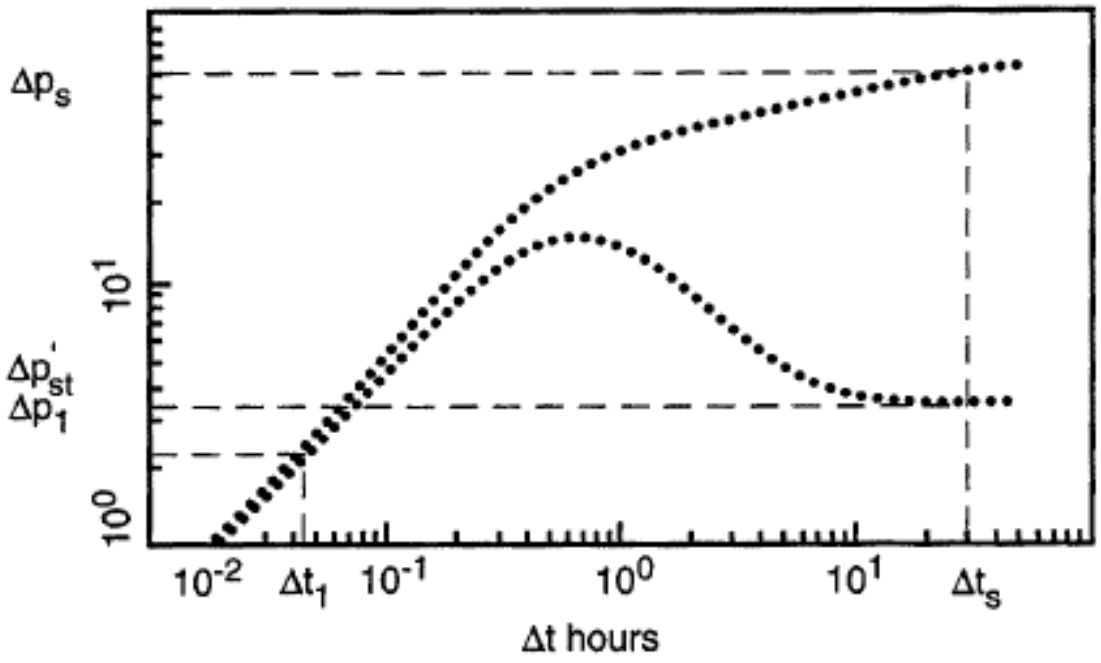

Fig. 6.4

Direct interpretation.../2

- The expression of $\Delta p'_{st}$ in relation to 0.5 is equal to:

$$\Delta p'_{st} = \frac{141.2\,qB\mu}{kh} \text{ x } 0.5 \quad \text{(in practical US units)} \qquad \textbf{(6.14)}$$

- It is used to calculate the reservoir's kh:

$$kh = 141.2\,qB\mu \text{ x } \frac{0.5}{\Delta p'_{st}} \quad \text{(in practical US units)} \qquad \textbf{(6.15)}$$

Direct interpretation.../3

- Wellbore storage can be calculated if the coordinates of a point located on the slope 1 straight line are known: Δp_1 and Δt_1.

- During dominating wellbore storage effect:

$$\Delta p_1 = \frac{qB}{24C}\,\Delta t_1 \qquad \textbf{(6.16)}$$

hence:

$$C = \frac{qB}{24}\,\frac{\Delta t_1}{\Delta p_1} \qquad \textbf{(6.17)}$$

Direct interpretation.../4

- The skin can be calculated if the coordinates of a point located on the semi-log straight line are known: Δp_s, Δt_s.

$$S = 1.151\left(\frac{\Delta p_s}{2.303\,\Delta p'_{st}} - \log\frac{\Delta t_s}{1+\frac{\Delta t_s}{t_p}} - \log\frac{k}{\phi\mu c_t r_w^2 + 3.23}\right) \quad \textbf{(6.18)}$$

- In the case of a varying flow rate, a superposition function must be used to calculate it.

Example 10

(In-class workshop)

Welltest Interpretation Using Software

In-class workshop

References

1. Bourdarot, Gilles : Well Testing: Interpretation Methods, Éditions Technip, 1998.
2. Internet.