Lecture Notes

PET504E
Advanced Well Test Analysis

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1 Introduction

The term "Well Testing" is used in Petroleum Industry means the measuring of a formation's (or reservoir's) pressure (and/or rate) response to flow from a well. The term "Well Testing" is generally used with the term "Pressure Transient Analysis", interchangeably. It is an indirect measurement technique as opposed to direct methods such as fluid sampling or coring. Well testing provides dynamic information on the reservoir whereas direct measurements only provide static information, which is not sufficient for predicting the behavior of the reservoir.

Simply, the objective of well testing is to deduce quantitative information about the well/reservoir system under consideration from its response to a given input. Input (or input signal) is used for perturbing one or wells so that the output (signal) exhibiting the response of the reservoir is obtained at the perturbated well and/or adjacent wells. In practice, the input is equivalent to controlling the well behavior [c1] created by changing the flow rate or the pressure at the well (Mathematically specifying the well behavior is equivalent to specifying a boundary condition). A common example for creating an input signal is [c2]a build up test [c3]where we change the rate to zero by shutting-in the well. Reservoir response, [c4] also called output signal, to a given input is monitored by measuring the pressure change (or rate change) at the [c5] well. This process is illustrated as,

[c1] *Murat Çınar*: ~~and~~

[c2] *Murat Çınar: Text added.*

[c3] *Murat Çınar*: ~~in which~~

[c4] *Murat Çınar*: ~~which is~~

[c5] *Murat Çınar*: ~~same~~

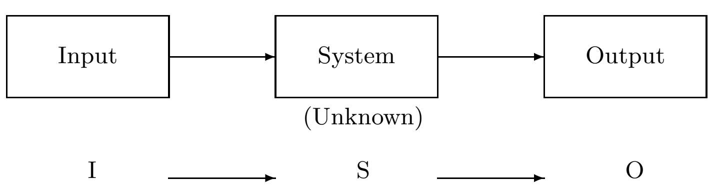

Fig. 1. Block diagram ?????

Typical examples for input and output signals as used in petroleum industry are shown in the following figures;

From reservoir response as monitored by the "output signal", we would like to determine information related to the followings

– Fluid in place; pore volume, $\phi h A$.

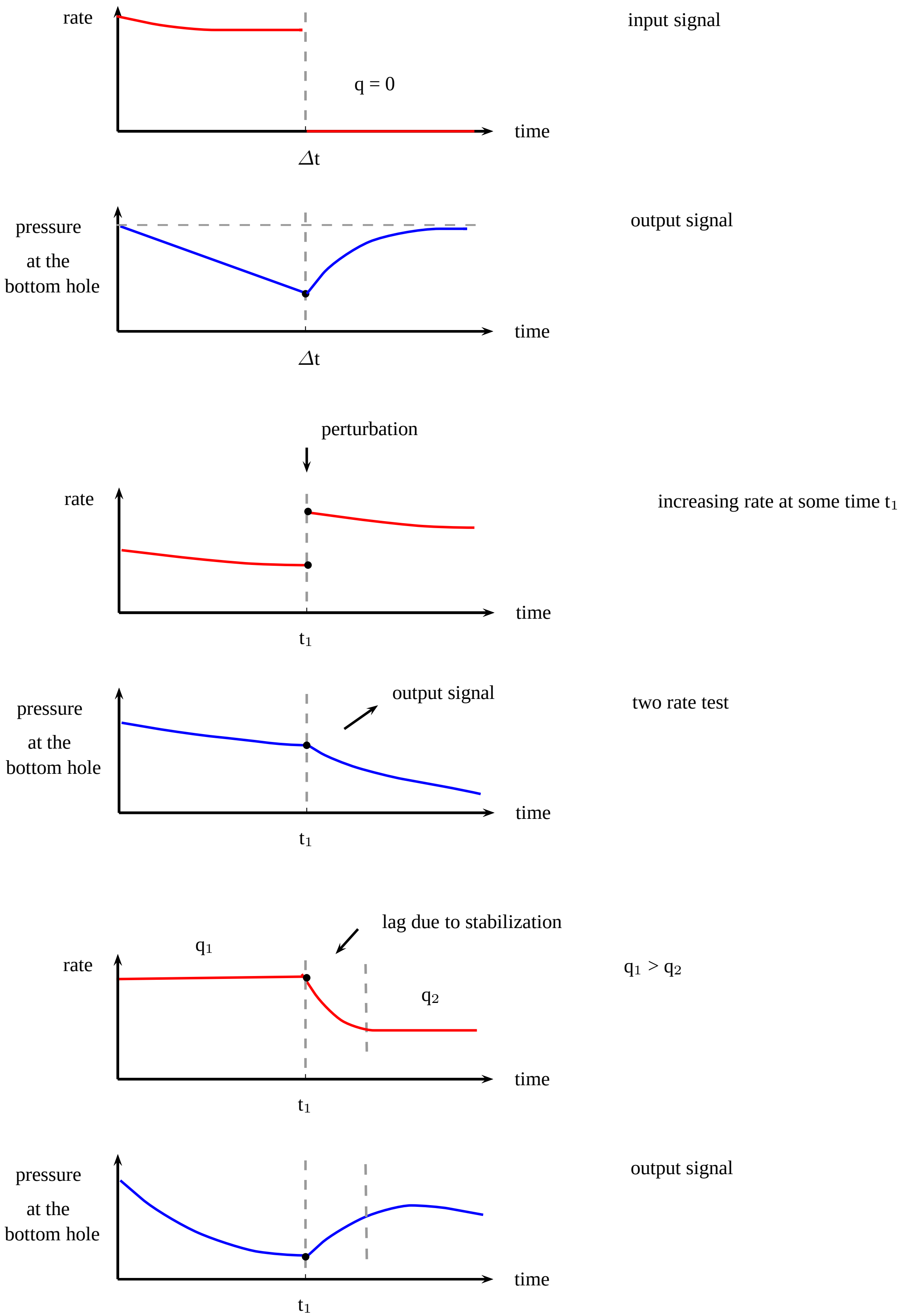

Fig. 2. Typical input and output signals - Transient phenomena.

– Ability of reservoir to transfer fluid, kh (or transmissibility, $\frac{kh}{\mu}$).
– Determination of average reservoir [c1]pressure, $\overline{P}$, which is the driving force in the reservoir [c2]
– Prediction of rate versus time data.
– Initial recovery, is the reservoir worth producing.
– Is there any damage around the wellbore impeding the flow? skin factor, s.
– Reservoir description (type of reservoir, flow boundaries (faults)).
– Distance to fluid interface [c1]that is important determining swept zone for secondary and tertiary methods.

[c1] *Murat Çınar*: ~~average~~

[c2] *Murat Çınar*: Based upon the explanation you gave about the pressure decline recently, I am not sure if this statement is correct.

[c1] *Murat Çınar*: ~~which~~

Interpretation of well test data consist of basically three steps:

(i) Determination of the one most appropriate reservoir / wellbore (mathematical) model [c2]of the actual system. We also call such a model as the interpretation model. [c3]Here our intention is to find a representative mathematical model that reproduces, as close as possible, the output of the actual system for a given input. This is known as the inverse problem. [c4]We are trying to obtain information about the physical system by using observed measurements. Unfortunately, the solution of inverse problem often yields non-unique results. [c5]By non-unique results, we mean that several different interpretation models [c6]may generate an output signal (response) to a given input [c7]that is similar (or identical) to that of the actual system. The inverse problem can be represented by the following equation.

$$\Sigma = O/I \ \approx S \tag{1}$$

where Σ denotes the interpretation model, S denotes the actual system. In inverse problem, as can be seen from Eq.1, it may be possible to obtain the same outputs to a given I for different Σ_i's[c8],however, the number of alternative models (solutions) can be reduced as the number and the range of output signal measurements.

(ii) determinatio ndldf komgf.

[c2] *Murat Çınar*: ~~to~~

[c3] *Murat Çınar*: ~~Here our hope is that the model chosen will produce an output signal to a given input which is as close as possible to that of the actual system.~~

[c4] *Murat Çınar*: *Text added.*

[c5] *Murat Çınar*: ~~With~~

[c6] *Murat Çınar*: ~~can~~

[c7] *Murat Çınar*: ~~which~~

[c8] *Murat Çınar*: ~~. However~~