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IMPROVED CALCULATIONS FOR BOTTOM HOLE INJECTION PRESSURE VERSUS DEPTH WHILE GAS INJECTION FOR PRESSURE MAINTENANCE OF TENGIZ FIELD

1. INTRODUCTION

Tengiz is a large carbonate reservoir in western Kazakhstan. Tengiz field (Fig. 1) is located on the south side of the 500,000 square kilometer (km^2) Pri-Caspian basin on the northeastern edge of the present-day Caspian Sea. Other giant oil and gas fields located in similar settings include Karachaganak and Orenberg. The reservoir has a very large areal extent. Tengiz is over 110 km^2 in area at its top and 400 km^2 at its base. The oil column is quite thick, as top of the reservoir is located at approximately –3,850 m subsea and the approximate oil water contact is at –5,450 m subsea.

The Tengiz reservoir is an isolated carbonate buildup ("platform") with a mesa-like geometry (flat-topped and steepsided). The platform has a slight regional tilt today of less than one degree to the south. The sides of the platform have much greater dip (approximately 25 degrees) on the flanks. The present-day geometry of the Tengiz structure is that of a topographically high-rim area surrounding a depressed central platform. It is flanked by a dipping platform-to-basin transitional facies along the flank, as shown in Figure 1. The Tengiz reservoir formed during the Late Devonian and Lower to Middle Carboniferous time by the deposition of calcareous skeletal fragments and lime mud. The cyclicity of these sediments was in response to the interplay of sea-level rise and basin subsidence. The platform appears to have drowned in late Bashkirian or early Moscovian time.

Tengiz oil field is situated in Zhyloy Region, Atyrau Oblast. It is located 250 kilometers away from Atyray city, the Oblast administrative center (Fig. 2).

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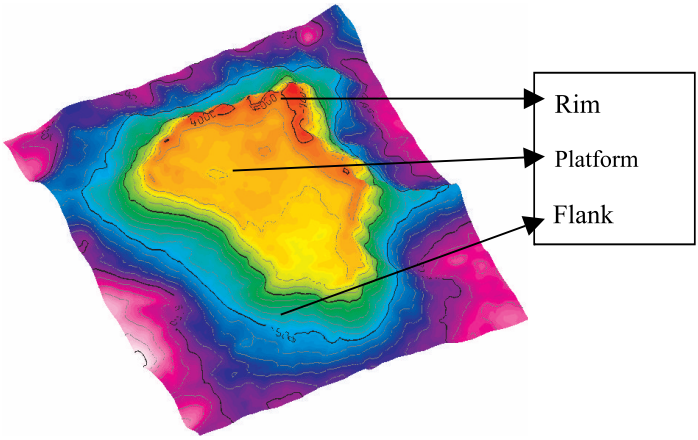

Fig. 1. The Tengiz Platform, Rim and Flank regions

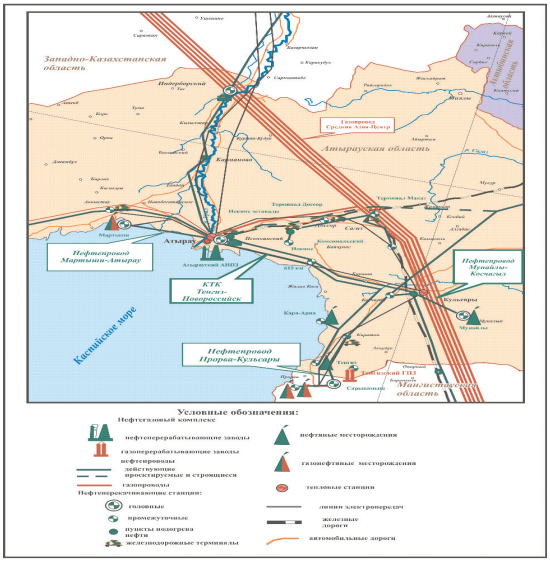

Fig. 2. General Purpose Map

Trunk oil pipelines and trunk gas pipelines cross the territory of the Region: ICA gas pipeline, Tengiz – Kulsary – Atyrau-Novorossyisk (CPC) oil pipeline, Uzen – Kulsary – Atyrau – Samara oil pipeline.

2. GEOLOGICAL AND PHYSICAL PARAMETERS OF THE OIL FIELD

Tengiz oil field belongs to Pre – Caspian oil and gas province. The Tengiz structure represents a large buildup with a vast flat platform and steep flanks.

On the date when the analysis was conducted 133 wells have been drilled in the oil field. Out of this number of wells 32 wells were drilled after the 2002 the "Technological Scheme for Developing the Tengiz Oil Field" had been developed. The new wells allowed clarifying lithological and stratigraphycal parameters, net reservoir thickness, permeability and porosity parameters of the reservoir within different structural and facial zones. As a whole significant changes in understanding of geological structure of the oil field were not introduced.

A total thickness of pay zone was included in estimation of net reservoir thickness except of clay deposits and tuffargillite deposits which were identified in logging were clearly.

The data collected from the well core has not change current understanding about oil bearing intervals but it is allowed clarifying parameters of the cross section with recovered core.

Properties of the reservoir crude oil do not change much from the crude oil properties used for estimating in the "Technological Scheme for Developing the Tengiz Oil Field". The Tengiz crude oil is a light crude oil, sour oil, low – resin oil, paraffin oil.

Geological/recoverable reserves of the Unit – 1 present 66.6/84% from the total reserves of the oil field. Reserves of the Unit – I and the Unit III present 25.1/12% and 8.3/4% of the reserves correspondingly from the total reserves of the oil field. 94% of the oil reserves of the stratigraphical Unit – 1, 75% of the oil reserves of the stratigraphical Unit – II and only 14% of the reserves of the stratigraphical Unit – II present commercial category $B+C_1$.

Standard and special purpose studies of the recovered core are being completed in the oil field. Geological and hydrodynamic 3D model is being detailed. On results of these projects production volumes and parameters of the deposits will be evaluated more correctly. Based on the results of this study oil reserves and dissolved gas reserves and associated components will be estimated in respect of the commercial category.

3. PREDICT BOTTOMHOLE INJECTION PRESSURE FOR LAYERS 1, 2 AND 3

Purpose: Improved estimates of bottom hole injection pressure versus depth in order to determine injectivity of various reservoir layers 1, 2 and 3.

Objective: Develop correlations for the 7 active injection wells to predict bottom hole injection pressures at the end of the tubing, middle of layer 1, middle of layer 2, and middle of layer 3. Each well will have its own individual correlation. These correlations may be based on factors such as depth, temperature, pressure and rate.

Steps:

1. Develop cartoon schematic of all 8 injection wells showing depths of pressure gauges, tops/bottoms of injection intervals, layers 1, 2 and 3.
2. Determine the depths needed for pressure estimation.
3. Collect data from periods of stable injection rate using software data.
4. Collect pressure data from injection well memory production logging test (MPLT) and PLTs using Emeraude programme.

5. Select highest quality data for pressure predictions.
6. Determine pressure predictions for the depths determined in step 2.
7. Compare predicted pressures with measured pressures from injection logs.

Cartoon schematic of 8 injection wells (Fig. 3): shows depths of pressure gauges, depth of end of tubing (EOT), tops/bottoms of injection intervals, layer 1, layer 2 and layer 3.

Well T-C is one of the Tengiz sour gas injectors (SGI). SGI-1 sweet gas injection started in March 2007 followed by SGI-2 sour gas injection starting in January 2008.

The well is completed with 4.5" tubing, and has a cemented casing across the perfs. A permanent down hole gauge is installed at 3943 m, and this gauge is the source of the pressure data for the fall off analyses.

We know depths needed for pressure estimates; afterwards we have to collect pressure data from injection well MPLT and PLTs using Emeraude programme. Do not average all the PLT passes.

There aren't any deviations of predicted pressure versus measured (Fig. 4).

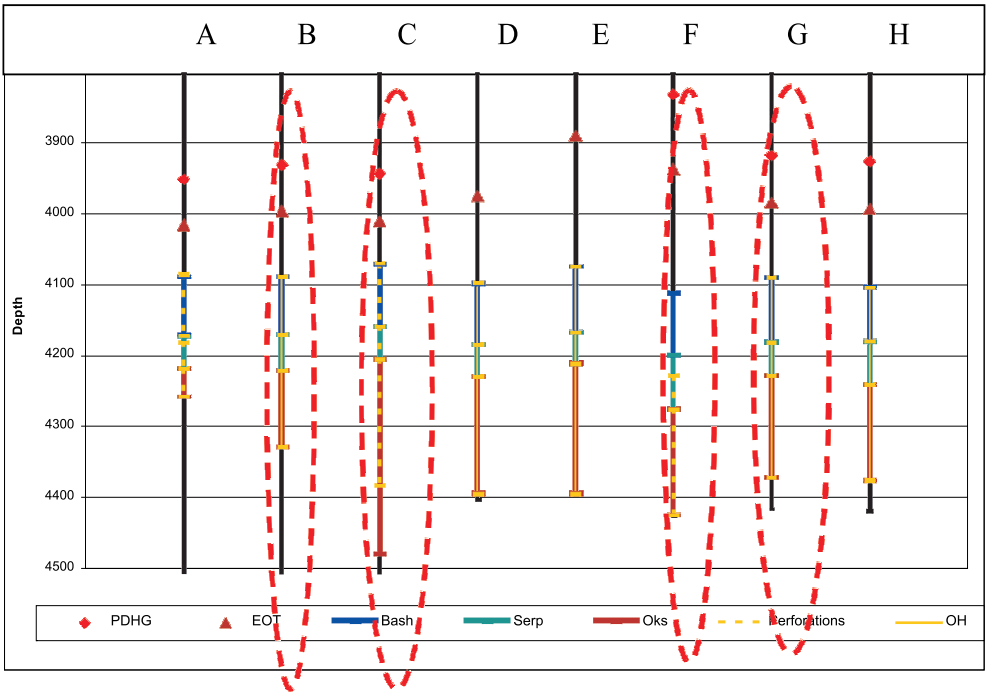

Fig. 3. Schematic of 8 injection wells

Then, collect data from periods of stable injection rate using software.

Colored lines have he same slope as the hydrostatic gradient. It means that there is not much pressure loss due to friction in this interval.

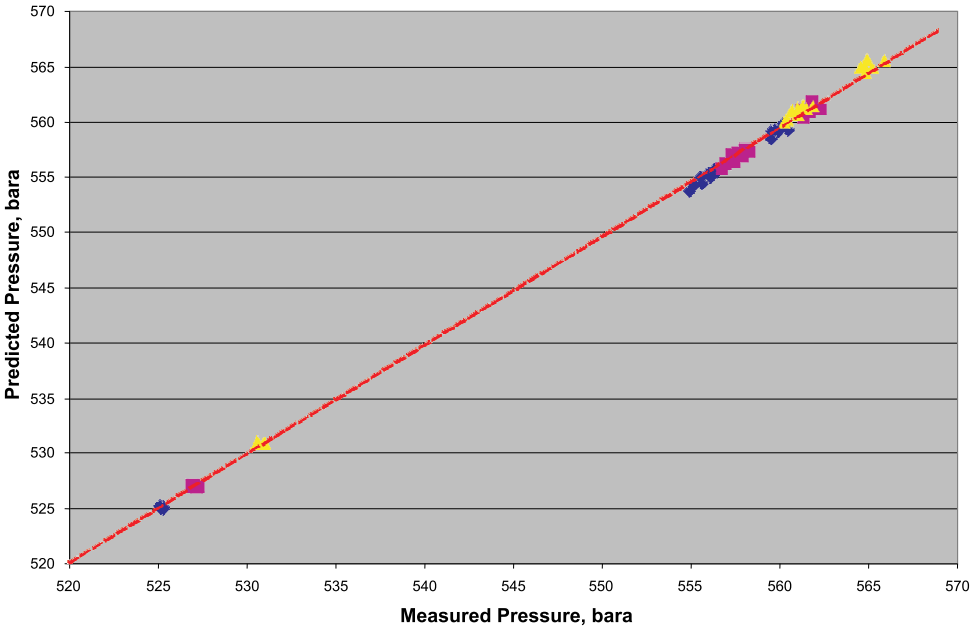

Fig. 4. Measured Pressure vs. Predicted Pressure

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