Fluid Loss Predication Using a New Filter Cake Model

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Abstract: In this study, a new model was developed to predict the fluid loss in (6%) bentonite drilling mud. In this model the hydraulic conductivity (permeability) of the filter cake was changing with time. The new model predicated the experimental results very well.

1. Introduction

It is generally known in the petroleum industry that drilling muds have a more complex flow behavior than Newtonian fluids, yet it is still common practice to express the flow properties of muds in terms of a single viscosity. The drilling muds characterized as plastic materials which obey the laws of plastic flow (Beck et al., 1947), or viscous materials where the viscosity change with the shear rate. When there is loss of water from the drilling mud filter cake are formed. Based on the rate of fluid loss the formation of filter cake will be affected and the permeability will vary with time. Based on the literature review the permeability of the filter cake varied from 0.023 to 170 µd while the ratio of the solid volume fraction in the filter cake to the mud varied from 3 to 4, (Elkatatny et al., 2012).

2. Objectives

The objective of this study was to introduce the concept of permeability change with time in the filter cake and compare it to the standard API infiltration equation. Both equations were compared with the real laboratory values of infiltration through filter cake for 30 minutes.

3. Methods and Materials

In this study, 6% bentonite drilling mud was used. The fluid loss was measured using the API-filter test equipment.

4. Model

The classical method to evaluate the infiltration through filter cake is given by the following equation (Andrea et al. 2012):

$$\mathbf{V_f} = \sqrt{\mathbf{2 * k * \Delta p * \left(\frac{f_{sc}}{f_{sm}} - 1\right)}} * \mathbf{A} * \frac{\sqrt{\mathbf{t}}}{\sqrt{\boldsymbol{\mu}}} = \mathbf{M} * \sqrt{\boldsymbol{t}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (\mathbf{1})$$

In the new model, it is assumed that the permeability of the filter cake changes with time and has the relationship as follows:

$$\mathbf{k(t)} = \frac{\mathbf{k_o}}{\mathbf{1+\beta t}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (\mathbf{2})$$

Where: filter cake parameter β(1/min) depends on the type of drilling mud and rate of fluid loss. Hence, the final form of the model will be as follows:

$$\mathbf{V_f} = \sqrt{\mathbf{2 * k_o * \Delta p * \left(\frac{f_{sc}}{f_{sm}} - 1\right)}} * \mathbf{A} * \sqrt{\frac{\mathbf{1}}{\boldsymbol{\beta\mu}}} * \sqrt{\mathbf{ln(1+\beta t)}} = \frac{\mathbf{M}}{\sqrt{\boldsymbol{\beta}}}\sqrt{\boldsymbol{ln(1+\beta t)}} \quad \ldots\ldots\ldots\ldots\ldots (\mathbf{3})$$

Where:

$$\mathbf{V_f = volume\ of\ fluid\ loss\ (cm^3), k = drilling\ mud\ permeability\ (darcy),}$$

$$\mathbf{k_o = intial\ permeabilty\ of\ drilling\ mud\ (darcy), \Delta p = applied\ pressure\ (atm),}$$

$$\mathbf{f_{sc} = volume\ fraction\ of\ solid\ in\ cake, f_{sm} = volume\ fraction\ in\ mud,}$$

$$\mathbf{A = filter\ area\ (cm^2), t = time(min), \mu = mud\ viscosity(cp),}$$

5. Results

Both API and developed equation were used to verify experimental results of the fluid loss infiltration as shown below:

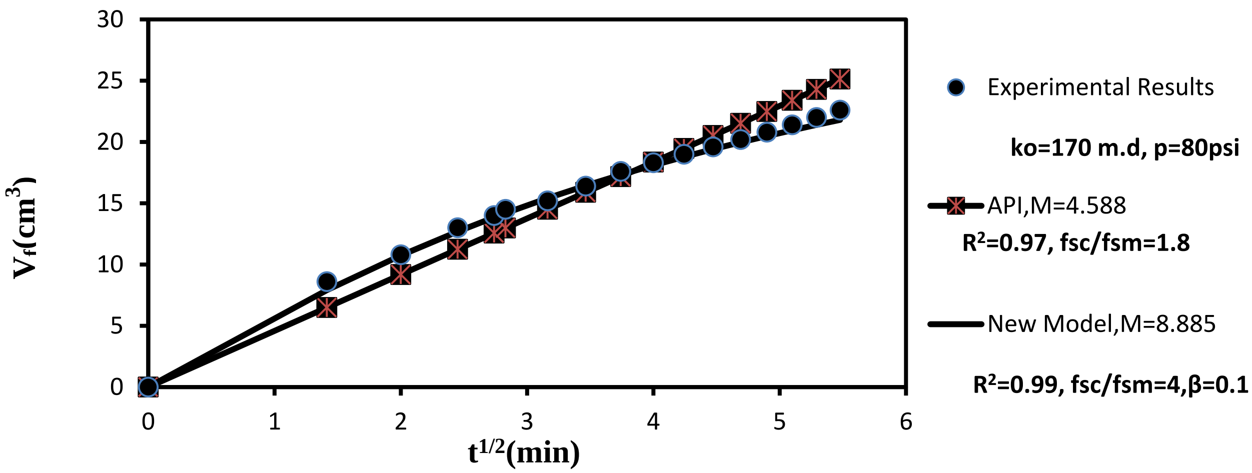

Figure 1. Comparison of Fluid Loss Model vs. API Model with Experimental Results.

6. Conclusions

The proposed model showed a very good agreement with the experimental results in predicting the fluid loss in the drilling mud.

7. Acknowledgement

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8. References

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