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A multi-well deep learning model considering geological and engineering parameters for the long-term forecasting of shale gas production

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The production forecasting of shale gas wells is an important research topic in the natural gas industry. The underground pore structure is extremely complicated after hydraulic fracturing. Conventionally, researchers try to construct forecasting models via theoretical or experimental approaches. However, both theoretical and experimental approaches are faced with difficulties. Firstly, many parameters required during the theoretical computations cannot be timely or accurately measured, which limits the usage of theoretical models. Secondly, experiments can hardly match the real scale since a typical shale gas well has several thousand meters in length and depth. As a result, machine learning has become a popular modelling approach in the production forecasting of shale gas wells under complex pore structures induced by hydraulic fracturing.

With the large-scale development of shale gas blocks, an increasing number of production records as well as geological and well completion data is becoming available. This enables the construction of shale gas production forecasting models using dynamic time series data as well as static geological and well completion data. The former represents the historical production features of a well while the latter reflects the underground pore structure. Nevertheless, most existing methods do not incorporate static parameters into the modelling process. Moreover, most existing methods apply a single-well modelling scheme where a model specifically trained for a target well is constructed. This scheme has two major flaws when it comes to field application. Firstly, it overlooks useful information from other existing wells in the same production block. Secondly, it requires a long piece of initial data for training and therefore cannot be used on newly developed wells. The problems faced with single-object methods have also been addressed in many other fields where the use of a long piece of initial data is impractical [1].

Considering the problems in existing shale gas production forecasting models, we propose a multi-well long-term forecasting model with static parameters. The proposed model is built on recurrent and fully connected neural networks and is trained on both production and static data from multiple existing wells. Since the training process does not need a long piece of production history from the target well, the proposed model can be used on a newly opened or re-opened well after a short initial period (for example, 14 days). Then, the long-term forecasting can be carried out iteratively using previously forecasted values. Therefore, the proposed model can achieve timely forecasting of shale gas production with both time-series data and pore structure after fracturing taken into consideration. The accuracy and usefulness of machine-learning-based shale gas production forecasting models are thus improved.

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References

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