**REVIEWER 1**

**Comment 1:**

Introduction: A general awareness about the development of hydrocarbon resources can be presented to the readers at the beginning of the introduction:

a) Best Practices and Methods in Hydrocarbon Resource Estimation, Production and Emissions Forecasting, Uncertainty Evaluation, and Decision Making, SPE Res Eval & Eng 5 (02): 146–153;

b) Modeling of microflow during viscoelastic polymer flooding in heterogenous reservoirs of Daqing Oilfield(2022). J. Pet. Sci. Eng. 210, 110091.

**Response 1:**

Thank you for the suggestion and the references. Based on your advice, we have made significant modifications to the introduction and added the recommended papers.

**Comment 2:**

To make the review article be more forward-looking, please outline the authors' detailed views on the key challenges, existing research gaps and future research directions etc., including also potential future developments in research methodologies that are important to future development of the related field. This section brings critical benefits to the readership.

**Response 2:**

The last section intends to bring to the reader's attention precisely such a view. We included it in the Conclusion section to point out the importance of these key challenges..

**Comment 3:**

Page 13 Line no. 546: “Error! Reference source not found”;…… please correct.

**Response 3:**

Sorry for that mistake. We have fixed it.

**Comment 4:**

Please do not use Table in the Conclusions, it is not customary.

**Response 4:**

Thank you for the comment. We have opened an exception in this paper because the table intends to provide a straightforward set of recommendations based on what has been discussed before. We have renamed the section “Conclusions and Recommendations” to emphasize that its purpose is beyond standard conclusions and also focuses on recommendations.

**REVIEWER 2**

**Comment 1:**

1. It is suggested to introduce the basic algorithm of EDFM in the text.

**Response 1:**

Thank you for the suggestion. We remark that the third paragraph of section 4 comments on the EDFM characterization workflow, and the ones that follow list the formulation.

**Comment 2:**

2. It is suggested to introduce the prominent advantages and disadvantages of various models in the

**Response 2:**

Thank you for the suggestion. Section 3 is dedicated to discussing the various models, but as the paper focuses on EDFM, the discussion of each method in detail would be overwhelming and defocus the reader. However, sections 5 and 6 deal with the different flavors of EDFM. We changed the text to emphasize the pros and cons, especially when dealing with low permeability fractures.

**Comment 3:**

3. It is suggested to add more explanations on the definition of fractures, such as geological, hydraulic fracturing mechanics.

**Response 3:**

Indeed, formal definitions of fractures and their classification are key to discussing DFM. We reserved section 2 for that. The first paragraph covers the best definition of fractures to our knowledge. The second paragraph describes the classification and the following present challenges and common issues during modeling.

**Comment 4:**

4. It is not recommended to provide multiple explanations for abbreviations. (as line 27 and 86, NFR is explained twice, as same as NF in line 38 and 105).

**Response 4:**

Thank you for your comment. The abbreviations were revised and only repeated in specific contexts, specifically when their definition is provided in detail.

**Comment 5:**

4. There are some citation errors in the figures and tables in the manuscript. Line 199、226、288、311、402、412 and 546.

**Response 5:**

Sorry for the mistake. It was fixed.

**REVIEWER 3**

**Comment 1:**

The abbreviation is incorrect. The first one should be labeled with the full name, while subsequent instances can be referred to by the abbreviation alone. Please review the entire text.

**Response 1:**

Thank you for your comment. Sometimes we prefer to re-state the abbreviation if it is important to the context – especially when the concept is described in detail. However, we agree with your comment and fixed the text in many places.

**Comment 2:**

In section 3, “Fractures as numerical entities” line 199-200. It is important to Carefully check the content of the article, and avoid any irrelevant content in the article.

**Response 2:**

Thank you for your comment. Indeed, the claim is generic, intending to bring closure to the section. We have rephrased it and moved the claim as an introduction to the section.

**Comment 3:**

All figure and table in text should be described and marked in paper and added a figure number in parentheses.

**Response 3:**

Thank you. Sorry for our mistake. We have reviewed the figure references and added (a), (b) … in each figure.

**Comment 4:**

There are many sections in the article. I recommend to merge the section of this paper. Such as section 6 and subsequent sections.

**Response 4:**

I appreciate your comment, which concerns readability and improved text flow. As a matter of writing style, we regard the section split and entitlement as an important overview of the paper itself, along with clear figures and tables. We are afraid that merging text into fewer sections with frequent context switches within each section would incur a lack of cohesion. We see this issue is related to writing style rather than content.

**Comment 5:**

In this study, these paper was classified the types of fracture, I recommend to explain the difference in subsequent sections, and It should be noted the differences between these different types of cracks in numerical simulations.

**Response 5:**

Thank you for the thoughtful suggestion. Section 2 (“Fractures as physical features”) presents the fracture types and challenges from the physical and geological perspectives for each type. Section 3 (“Fractures as numerical features”) discusses the mapping of fractures using varied numerical approaches. Finally, the recommendation table in the last section uses the type of fractures as a criterion for model selection.

**Comment 6:**

All the figures containing subfigures should annotated in the subfigure using (a) and (b), such as figures 4, 5, and 6.

**Response 6:**

Thank you for bringing that to our attention. The figures and respective descriptions were updated according to your suggestion.

**Comment 7:**

In section 5 “Low-permeability fractures”, I recommend to add some data to demonstrate the impact of technological changes on fracture model.

**Response 7:**

Thank you for your contribution. While the idea of this paper is not to produce original data, we preferred to explicitly cite one work from Li and one work from Chai (full references are below), both showing the volume split issues when low-permeability fractures cut a matrix cell. We also added a couple of new sentences in this section to clarify our point.

Li L, Lee SH. Efficient field-scale simulation of black oil in a naturally fractured reservoir through discrete fracture networks and homogenized media. SPE Reservoir Evaluation & Engineering 2008;11:750–8.

Chai Z. An Efficient Method for Fractured Shale Reservoir Simulation and History Matching: The CEDFM Approach. 2018.

**REVIEWER 4**

**Comment 1 and 2:**

In your introduction briefly connect the importance of fracture modeling to broader implications in the field of hydrocarbon extraction and energy resources.

The introduction is comprehensive but could benefit from improved clarity and flow. Breaking down some of the longer sentences into shorter, more digestible parts could enhance readability.

**Response 1 and 2:**

Thank you for your comment. We have added significant content and reorganized the introduction to cover your concerns.

**Comment 2:**

Please state the novel contributions of the paper in the introduction. This helps readers understand the unique aspects of the research and its significance.

**Response 3:**

Thank you for bringing up this aspect. I have updated the last two paragraphs in the introduction to clarify the paper's relevance and text organization. We strongly believe this work's contribution is to provide a critical review of the area with guidance for future researchers' work.

**Comment 4 and 5:**

4) Please review line 199 and 200 (Error! Reference source not found)

5) Please review all the figures reference in the text.

**Response 4 and 5:**

Sorry about that. It should be ok now.