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KEYNOTES

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Process Safety Challenges for a Sustainable Energy Policy in the 21st Century

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ABSTRACT

The fundamental transformation of the current extractive fossil fuel energy economy to a sustainable energy economy is a critical grand challenge facing the world today. This transformation requires a collaborative effort by all stakeholders (*i.e.*, government, industry, academia, and public interest groups). It also requires broad, science-driven approaches that promote energy independence, enhance environmental stewardship and reduce energy and carbon intensity and generate continued economic growth through innovation in energy technologies and expansion of green jobs. The need for process safety and risk management is intricately woven through all these activities. This presentation is focused on four things, namely the need for research, process safety and sustainable development, the need for a rational and constructive dialogue on risk, and globalization. An important issue is teaching and mentoring the next generation in the quest for new knowledge and understanding of the world we live in. Research is integral to teaching and universities have an important role in this, the question is how the research should be funded. Clearly, from the ancient times, countries and societies that have funded research have prospered.

With regard to who should fund the research, the main problem arises in the type of research, fundamental or applied. There is a saying that universities are interested in the "R" that is the research part of R&D, and industry is primarily interested in the "D" that is the development part of R&D. My opinion is that both universities and industry should try to move a bit closer to each other. There is a reason that R&D is always lumped together. If there is no progress in research, there is no development. Also, since the time scales of research in universities is typically longer, it results in more incompatibility. So, I believe that there should be an accommodation from both universities and the industry. Close industry-university interaction is essential to foster this new paradigm. Finally, government has also a significant role in boosting support for research, both fundamental and applied. As a bottom line, research must continue to be funded at a very significant level or we as a society will go the way of dinosaurs-- that is become extinct.

Our engineering education today lacks integration of knowledge needed for modern industry practice, and is inadequate in providing students with an understanding of societal impact and global role of engineering. My vision for engineering education brings together elements of manufacturing, design and sustainable engineering in an integrated form. And interwoven through this new paradigm is the consideration of risk in every aspect. An engineer must function as a member of the global community.

This means not only competing in the global marketplace, but also acting as a professional who shares the global responsibilities. These responsibilities entail proper account of the finite world resources, sensitivity to the impact on the environment, ethical conduct, process safety, risk consideration and much more. Today's engineering education largely neglects preparing our graduates to meet these challenges. This "extra", but much needed aspect may be called "the sustainability dimension" to engineering education and practice, is much needed for a building a sustainable energy policy in the 21st century.

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Heat Transfer Principles Applied to Oil and Gas Production

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ABSTRACT

Since the early days of petroleum production, data from pressure gauges have been used for analysis of various reservoir and well flow characteristics. Temperature data, however, have not found similar applications. That lack of temperature data usage has slowly changed over the years, especially over the last two decades. This talk describes the gradual increase in use of temperature data and discusses the possible future applications of these data.

Temperature analysis owes its increased application to the better understanding of heat transfer in wellbores. Ramey (1962) was the first to model wellbore heat transfer to estimate flowing fluid temperature of a single-phase fluid being produced or injected along a single conduit. It took nearly four decades for researchers (Alves et al., 1992; Sagar et al., 1991; Hasan and Kabir, 1994) to offer improvements to Ramey's model to handle multiphase flow. Temperature models for flow through multiple tubes, including gas-lift and drilling operations, started to appear in the later part of nineties (Hasan and Kabir, 1996; Hasan et al., 1996). Modeling off-shore production and other situations where wellbores with varying inclinations and encountering differing geothermal gradients, had to wait another decade (Hasan et al. 2009).

The advent of accurate temperature sensors – such as fiber optics (DTS) and distributed sensor array (DSA) – has allowed development of a number of applications of temperature models. Chief among these applications is flow rate estimation from temperature data that depend on using the temperature-rate relationship to estimate rate. Using temperature at the wellhead can thus allow monitoring flow rate when bottomhole temperature is available (Hashmi et al., 2015; Kabir et. al., 2012). In addition, DSA is particularly suitable for estimating zonal contributions (Kabir et. al., 2014).

Recent development of deep water assets and unconventional reservoirs could offer further usage of temperature data in the future. Attempts to use wormback data to estimate the location and size of fractures created in unconventional reservoirs using cold water for fracking, has not been very fruitful because of the complexity of geometry and fluid flow. Similarly, early-time DSA data from deep water wells have been difficult to use for rate profiling because of the near-wellbore cooling affected by drilling, cementing, and completion fluids. These, and other similar modeling and application of temperature data, will dominate the research efforts in this area for the next decade.

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Challenges towards True Reservoir Emulator

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ABSTRACT

Reservoir modeling is one of the keys to predict the future performance of a reservoir. It is a critical component in the development, planning and production management of oil and gas fields. The ultimate goal of reservoir modeling is to aid the decision making process throughout all stages of field life. Currently, literature shows that few models include non-Darcy flow under multiphase flow conditions, even fewer use non-Darcy equations for dual-porosity, dual-permeability description, and none uses transition between various flow regimes within porous media and fracture networks. Further, there is a limited number of studies on non-Newtonian nature of petroleum fluids. Fortunately, recent advancements make it possible to solve complex non-linear equations, therefore helping to remedy some of the shortcomings of previous modeling efforts. This research focuses on dealing the complex reservoir rock and fluid interactions with modeling and numerical solution that will lead to the development of more accurate, state of the art, performance prediction tools i.e. reservoir emulator.

Numerical solutions of non-linear equations, including considerations of time function both in fluid and rock systems, will produce multiple solutions, forming a cluster of points. These points will be tagged with confidence values, based on a recently developed advanced, fuzzy logic technique. Because a complex and computationally cumbersome process is expected to emerge, parallel computing is both necessary and complementary.

Proper addressing of the new models eliminates spurious assumptions in order to move toward the direction of knowledge-based modeling. The analysis of real challenges will open a new dimension of research ideas in reservoir modeling and simulation. This study will help developing a reservoir emulator for accurate prediction and forecasting of the reservoir an in-depth analysis of the reservoir before taking any decision of developing a simulator.

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