CHEMICAL EVALUATION PROCESS REVIEW- QUALIFYING CHEMICALS FOR OILFIELD APPLICATIONS TO REDUCE ENVIRONMENTAL CONCERNS WITHOUT SACRIFICING PERFORMANCE

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INTRODUCTION

Environmental stewardship involves not only responsible use of chemicals and materials during drilling and completions, but also includes a thorough understanding potential health and environmental hazards posed by chemicals used in these processes. Recent focus on potential hazards associated with chemicals used in oil and gas production has expanded to include not only chemicals used in treatments such as hydraulic fracturing, but to other applications including cementing and drilling fluids. Global focus on chemical disclosure and increased attention on chemicals covered by trade secret protection is driving the industry to assess products used in production processes and consider viable alternatives to address public and regulatory concerns while encouraging product innovation to reduce environmental or human risk. A comprehensive review of products and their components using a scientifically based program is fundamental to the identification of potentially unacceptable hazards and can support efforts in product reformulation, where applicable, to produce an efficient and compatible product that may pose fewer or less severe health and environmental hazards.

COMPREHENSIVE PROGRAM DEVELOPMENT

A Chemical Evaluation Process Review (CEPR) is a robust evaluation program implemented as a process to improve the development of chemistries that have been vetted both technologically for performance and scientifically for sustainability. The program examines products from upstream, midstream and downstream applications on a component level for various environmental and health hazards in accordance with established standards by considering: the presence or absence of specified substances; the likelihood of a product passing a comprehensive North Sea Oslo Paris Commission (OSPAR) pre-screen; global screening of substances for regulatory lists; and a detailed review of environmental, toxicological and physical hazards.

Products are scrutinized through this evaluation process by qualified scientists including human health and environmental toxicologists, biologists and environmental scientists. A process to protect confidential business information (CBI) for vendors submitting data has been considered and a qualified third party consultant evaluates products or components with CBI data. The CEPR reviews products both on a component level and on a product level (as packaged for use) and is separated into four distinct sections.

Highly Discouraged Substances

All products in the evaluation are subjected to a screening of components against widely known and well-studied substances that have been determined, by the international scientific community, to persist in the environment, bioaccumulate through the food chain, and pose a high degree of risk of causing serious toxic effects to human health and the environment. The screening process considers US Environmental Protection Agency (USEPA) and the United Nations (UN) lists of chemicals of concern and is updated accordingly if new chemicals applicable to the oil and gas industry are added.

North Sea OSPAR Pre-Screen

Components are assessed to determine the potential to meet North Sea regulatory criteria which are pertinent to the oil and gas industry. The program uses an OSPAR Pre-Screen Prediction Tool to examine the biodegradation, bioaccumulation and toxicity of components based on Harmonized Mandatory Control System (HCMS) OPSAR criteria. The pre-screen is intended to provide a prediction of a product's likelihood of passing a comprehensive OSPAR screen and is not intended to be a definitive assessment; as the data requirements for regulatory approval under the HCMS OSPAR program are more extensive than the pre-screen tool.

The OSPAR Pre-screen is utilized as a first pass assessment and results are utilized for internal decisions regarding expansion into new markets and potential product development and are expressed as a pass or fail. The pre-screen tool is utilized as an internal aid to guide decisions not only for operations in the North Sea and surrounding markets, but for global applications as several countries outside of the North Sea have adopted pre-screen criteria as an approval process for offshore oilfield chemical use. Additionally, some operators are now internally imposing OSPAR criteria for products that they utilize in the Gulf of Mexico.

Regulatory Lists

Components are screened against twenty-two (22) regulatory lists globally to provide an understanding of the potential level of regulatory control and impact for constituents of products being developed or used. It is a relative assessment of impact, and is not a pass/fail evaluation, and does not provide a regulatory or legally binding evaluation. Being present on a list(s) will indicate what regulatory hurdles and level of impact during use that may need to be overcome before a product can be developed for or sold to different regions globally.

Chemical Hazard Evaluation

Individual components are assessed for a total of twelve (12) environmental and toxicological hazards. These hazards include endpoints such as aquatic toxicity, biodegradation, carcinogenicity, developmental and reproductive toxicity, and flammability. The entire product is also screened for physical hazards including flammability, combustion, explosiveness and corrosion. A numerical score is assigned to each endpoint, based on the severity of the hazard. The total score is calculated from the component scores, weighted by the percent composition each component in the product. In order to assess products conservatively and consistently, components for which data is either withheld by a vendor due to CBI concerns or is insufficient to adequately assess hazards will be given the maximum score allowable to represent a worst case scenario.

QUALIFYING CHEMICALS AND PROCESS FOR IMPROVEMENT

After a product has undergone extensive review in the CEPR program, the results are reviewed and weighed against established criteria to determine if a product is qualified for classification under an established environmentally preferred product program. Qualification standards include the elimination of products that contain specific chemicals of concern identified by regulatory agencies or stake holders, a maximum chemical hazard numerical score, and elimination of components that are identified with a particular hazard phrase. To be considered under the environmentally preferred product program and effectively marketed to stake holders as a viable alternative to conventional chemistries, a product must meet all the criteria specified in this section.

Prohibited Components

Components within a product will not contain specific chemicals of concern identified internally, by regulatory bodies and by other stake holders. Other specific chemicals of concern identified by NGOs and operators who have established their own chemical evaluation programs are also considered. Specific chemicals that are prohibited are listed by one or more of these programs or regulatory lists: CEPR Highly Discouraged Substances, USEPA Permitting Guidance for Oil and Gas Hydraulic Fracturing Activities Using Diesel Fuels-Draft: Underground Injection Control Program Guidance #84, and the USEPA Priority Pollutants Program.

Hazard Phrases

Products are screened against hazard phrases as defined under the Global Harmonization System/Classification, Labeling and Packaging (GHS/CLP) for genotoxic, carcinogenic, and developmental and reproductive hazards. Chemicals identified as a carcinogen (H350 or H351), mutagen (H340 or H341) or reproductive toxins (H360 or H361) are considered. Products containing CAS numbers that are shown as *Harmonized* in the Classification and Labeling Inventory Database for the aforementioned hazard phrases are not qualified.

Maximum Chemical Hazard Numeric Score

Products must have an overall numeric Chemical Hazard Score that is below an established benchmark. Products with scores that exceed the established benchmark are not qualified, but can be further evaluated and may be considered for formulation changes made to aid in lowering the score.

Non-qualified Products

As a process of improvement, products that do not meet all of the aforementioned criteria for the environmentally preferred product program may be considered for potential reformulation. A consortium of research and

development scientists, product line managers, environmental scientists and HSE representatives examine products that have not met the internal screening standards. Considerations for product replacement and/or reformulation are discussed and weighed against several factors including product volumes sold, the existence of adequate alternatives for replacement, potential reformulation costs and product performance.

Industry Acceptance

Environmentally preferred products have been the focus of several operators and service providers in response to growing demands from regulatory bodies and the public for safer alternatives to conventional chemistries utilized in hydraulic fracturing and other applications in the oil and gas industry. An operator expressed interest in its utilization of environmentally preferred, qualified products for the regions in which it operated. In response to this request a system for tracking utilization of these products was initiated. As utilization was reported to the operator, additional data was requested on a quarterly basis. Quarterly reports are now provided to a subset of customers whose corporate governance promotes a commitment to environmental stewardship and in some cases the use of environmentally preferred products in their operations. Data trends are highlighted in reports to demonstrate any fluctuations in usage of these environmentally preferred products.

Included in these reports are high volume conventional products that have been utilized with suggestions for potential alternative products that are environmentally preferred, when applicable. Figure 1 illustrates utilization of qualified products for the 1st through 3rd quarters of 2012 for a subset of customers who receive quarterly reports. Data trends indicate an increased utilization of environmentally preferred products in comparison with conventional products that do not meet qualification standards. Through the 3rd quarter of 2012, over 400 clients have qualified their products under the program, demonstrating a proactive and commercially accepted solution for environmentally preferred product use.

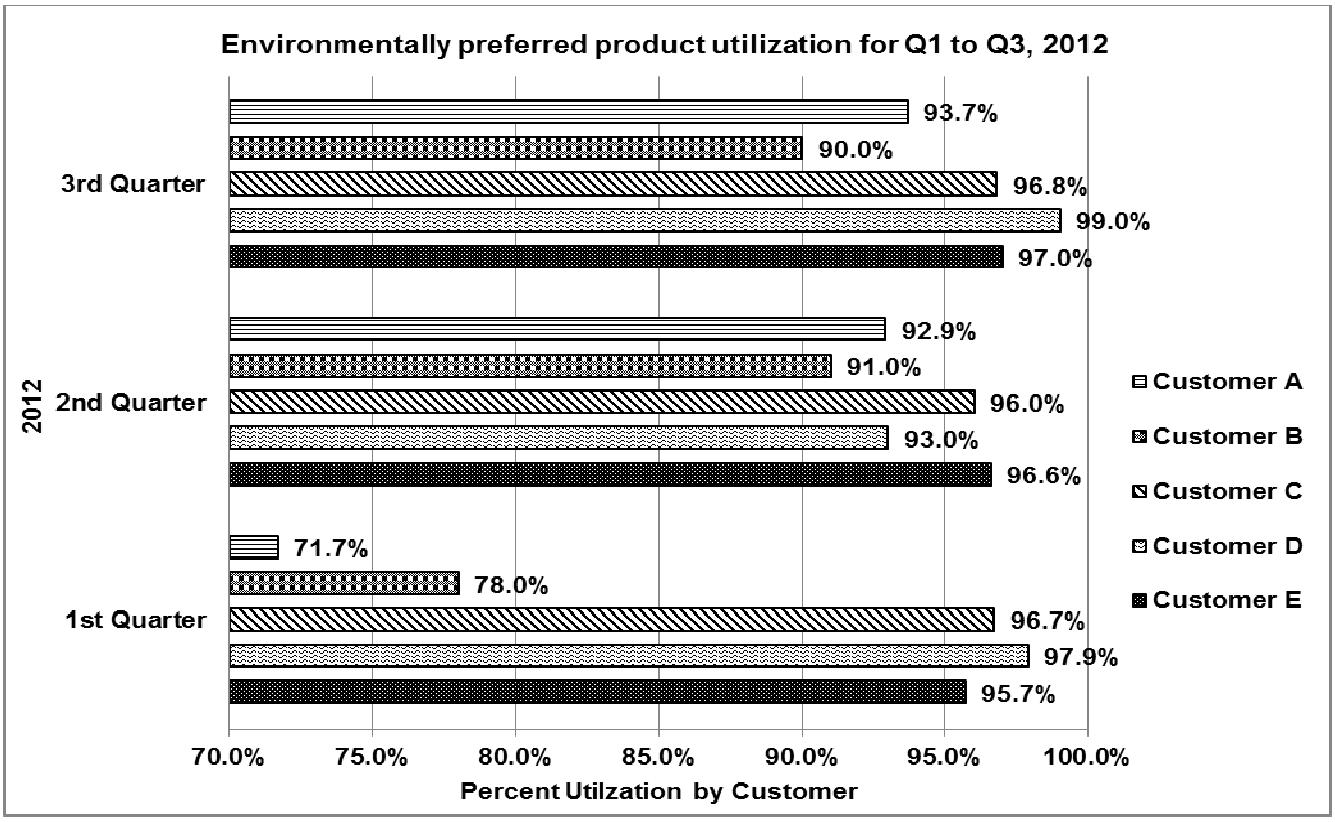

Figure 1 – Utilization of environmentally preferred products by a subset of operators in the US land market.