FLAWLESS DESIGN CORPORATION

Memo

To: Design Groups

From: Project Managers

Date: 03/31/2015

Re: Design Project

Enclosed is the letter that we received from UCD Chemicals regarding their plans to build a plant for the production of ethanol-amines from ethylene oxide and aqueous ammonia. First, we would like you to conduct a preliminary study on the production of ethanol-amines, and report to us by a 3-4-page report by **April 9, 2015**. Your report should include a brief description and assessment of existing technologies/processes for ethanol-amines production, a possible flow sheet for the proposed process, along with the economic potential of the project based on the input/output information. Also pay attention to the points of investigation suggested in the attached memorandum from UCD Chemicals. Since the production site is expected to be inside the U.S., we would like you to investigate the environmental and economic impact of the project on the domestic and world markets as well as any existing regulations that govern production and transportation. Organize your report to present all information in a neat, concise manner and use Appendices when appropriate. Make sure to state and justify any assumptions that you make in the course of your analysis. In one appendix, discuss briefly your information search strategy and the reliability of your sources.

UCD Chemicals

2015 Main Street
Central City, Illinois

MEMORANDUM 2015-01

March 31, 2015

Project Managers,
Flawless Design Group
One Bainer Bikeway
Davis, California

Our Industrial Chemicals Division is investigating expanding our gas treating market for ethanol-amines. Ethanol-amines have long been used as acid gas (H_2S and CO_2) absorbents. Of particular interest is the potential increase in mono-ethanolamine (MEA) demand for carbon dioxide capture from power plant and industrial furnace flue gases. Ethanol-amines are also consumed in the manufacture of detergents, surfactants, agricultural products, and textiles.

Ethanol-amines are produced by reacting ethylene oxide (EO) with aqueous ammonia (NH_3) in the liquid phase/supercritical phase without a catalyst. The addition of one EO molecule forms mono-ethanolamine (MEA). A second EO molecule forms di-ethanolamine (DEA) and a third EO molecule forms tri-ethanolamine (TEA). We plan to produce all three ethanol-amines and the ratio of these products depends on the reaction conditions. In addition, a small amount of by-product ethylene glycol is formed.

We feel confident that we can secure feedstock for ethanol-amines production in the Gulf Coast area. A potential site for an ethanol-amines plant would be Beaumont, Texas. Our analysis indicates the market can support a 100 million pound ethanol-amines/year facility.

To assess the commercial viability of this project we need your group to prepare a conceptual design package and economic evaluation for the production of ethanol-amines. As a starting point, use an ethylene oxide price of 60 cents/lb and anhydrous ammonia price of 30 cents/lb. MEA, DEA, and TEA are tentatively priced at 85, 96, and 91 cents/lb respectively.

In anticipation of the ethanolamine project, our Technology Group has been gathering information concerning the reaction kinetics and should be available in a week or so. The attachment provides some background on the chemistry of ethanolamine formation.

My staff will assist you in developing project and process premises and you will receive further memos with additional details. However, if you have any questions at this point, please do not hesitate to contact me or my staff.

Ethyl O. Amean
Manager
Industrial Chemicals Division

Attachment

Ethanol-amines are produced by reaction of ethylene oxide with excess aqueous ammonia. The reaction to higher ethanol-amines proceeds sequentially with the addition of one EO molecule. Additionally, EO reacts with water to form Ethylene Glycol (EG). The reactions are carried out at 60 -- 150 C and a sufficient pressure (500 – 2000 psig) to maintain liquid or supercritical conditions. Aqueous ammonia concentrations of 50 - 100 wt % have been used. Generally a molar ratio of NH_3/EO from 5/1 to 20/1 are employed and have a strong effect on the ethanolamine product distribution.