Acrylic Acid Process

Due to the scarcity of oil in the future, alternative resources and production pathways for the production of chemicals need to be identified. To allow for an economic production of these

chemicals, the use of innovative equipment and methods has to be investigated to intensify the processes. Reaction distillation integrates separation by distillation and reaction into one unit and is already known to be a promising concept to improve process performance, leading to more sustainable

processes. However, the design of reactive distillation processes using bio-based raw materials is difficult because the wide impurity profile of the reactants may lead to a large number of additional reactions and thermodynamic non-idealties. Hence, within this work, a 4-step methodology for

the design of a reactive distillation column processing bio-based resources is presented. In this study, the focus is on the impact of impurities, resulting from the use of bio-based raw material. Based on these results, the product purity in presence of the impurities is analysed and operational and

design changes to overcome identified product purity limitations will be presented.

This report presents a cost analysis of Ester-Grade Acrylic Acid (EAA) production from ethylene oxide using a carbonylation process. The process examined is similar to Novomer process. In this process,

ethylene oxide is catalytic carbonylated to beta-propiolactone intermediate, which is then converted to Acrylic Acid. The final product obtained is EAA, which is used in the production of acrylic esters. This report was developed based essentially on the following reference(s): WO Patent

2013126375, issued to Novomer in 2013

Keywords: Propenoic Acid, Polypropiolactone, Carbon Monoxide, Acrylate Esters, Cornell Research Foundation, Celanese, Ketene

This report presents a cost analysis of Ester-Grade Acrylic Acid (EAA) production from propane. The process

examined is a novel process for propane oxidation. In this process, propane is fed to an oxydehydrogenation reactor in the presence of steam to form propylene. The propylene-containing gas passes through a two-stage vapor phase oxidation to generate an acrylic acid-

containing gas, from which acrylic acid is recovered via absorption in water. The aqueous acrylic acid solution is purified via light solvent extraction to Ester-grade Acrylic Acid (EAA). This report was developed based essentially on the following reference(s): (1) "Acrylic Acid and

Derivatives", Kirk-Othmer Encyclopedia of Chemical Technology, 5th edition (2) US Patent 6492548, issued to Union Carbide in 2002

Keywords: Propene, Air Oxidation, Propenoic Acid, Nippon Shokubai, Rohm & Haas, Dow

Purification Process for Acrylic Acid

23 European

Symposium on Computer Aided Process Engineering Hydrophilic Polymer Based on Acrylic Acid Alkali Metal Acrylate, Process for Producing Same and Use Thereof as an Absorbent Particularly for a Physiological Solution Bio-Acrylic Acid Production from Raw Sugar - Cost Analysis -

Acrylic Acid E42B Butyl Acrylate Production from Propylene and Butanol - Cost Analysis - Butyl Acrylate E21A

This report presents a cost analysis of Ethyl Acrylate production from acrylic acid and ethanol The process examined is a typical

esterification process. In this process, acrylic acid and ethanol are esterified in a fixed-bed reactor producing Ethyl Acrylate. This report was developed based essentially on the following reference(s): Keywords: Ethyl

Alcohol, Lower Alkyl Acrylate, Ethyl Propenoate

This report presents a cost analysis of Glacial Acrylic Acid production from crude acrylic acid. The process examined consists of a typical distillation/ purification process. This report was

developed based essentially on the following reference(s): "Acrylic Acid and Derivatives", Kirk-Othmer Encyclopedia of Chemical Technology, 5th edition Keywords: Propenoic Acid, Commercial Grade

Acrylic Acid, Propylene Oxidation, Rohm and Haas, Dow, Flocculant Grade, GAA-FG

This report presents a cost analysis of n-Butyl Acrylate production from ester grade acrylic acid and n-butanol The process examined is a typical

esterification process. This report was developed based essentially on the following reference(s): (1) "Acrylic Acid and Derivatives", Kirk-Othmer Encyclopedia of Chemical Technology, 5th edition (2) US Patent

6320070, issued to BASF in 2001

Keywords: Esterification, Nippon Shokubai, Mitsubishi, BASF

A new method of seawater desalination via acrylic acid based hydrogels: Synthesis, characterisation, and experimental

realisation

Removal of Acrylic Acid (AA) from Process Water by Using Alumina

Process for Producing Powdered Polymers of Acrylic Acid and Methacrylic Acid and Use Thereof

Process for the Production of Esters

of Acrylic and Methacrylic Acid Z(nfpa-acrylic Acid) zcopolymerization Characteristics and Process Development

The field of petrochemicals started some years ago with the simple addition reaction of water to propylene

for the production of isopropyl alcohol. Currently, the petrochemical industry has become a multi-billion dollar enterprise which encompasses a wide field of chemical products. Almost all the basic organic reactions such as

hydrogenation, alkylation, substitution, polymerization, etc. are utilized for the production of these chemicals. It may not, however, have been possible to establish this huge industry without the use of different

catalysts. In other words, the great advancements in the catalytic area have supported the vast developments in the petrochemical field. In this book, we have adopted the idea of discussing the petrochemical industry from the

point of view of reactants' activities and susceptibilities toward different catalysts. The book is thus classified according to the reaction type. This will eriable students and other users of the book to base their understanding

of the petrochemical field on the fundamental principles learned in chemistry. How ever, the first chapter is aimed at establishing some basic facts on the petro chemical industry and its major uses. It discusses, without

going into details, the raw materials used, the intermediates and the downstream products. The next eight chapters discuss in some detail the main reactions and the catalysts used for the production of

chemicals and polymers from petroleum. The last chapter is devoted to a discussion of some of the practical techniques used in the catalytic field. This report presents a cost analysis of bio-based Acrylic Acid production from

glucose syrup using a direct fermentation process. The process examined is similar to the speculative process proposed by the Delft University of Technology. In this process, a biological agent is able to directly convert glucose to

Acrylic Acid through an anaerobic metabolic pathway. The process uses a 70 wt% glucose-water syrup as raw material and the final product obtained is Glacial Acrylic Acid. This report was developed based essentially on the

following reference(s): Straathof, A. et al., "Feasibility of Acrylic Acid Production by Fermentation", Applied Microbiology Biotechnology, 2005, 67:727-734 Keywords:

Bioacrylic Acid, Anaerobic Fermentation, Dextrose, Propenoic Acid, Unsaturated Carboxylic Acid, Green Acrylic Acid, Renewable Feedstock

This report presents a cost analysis of n-Butyl Acrylate

production from chemical grade propylene and n-butanol The process examined is a typical propylene oxidation, followed by a typical esterification process. In this process, propylene passes through a two-stage vapor phase

oxidation to generate an acrylic acid-containing gas, from which acrylic acid is recovered via absorption in water. The aqueous acrylic acid solution is purified via light solvent extraction to ester-grade acrylic acid to be combined

with n-butanol in a esterification reactor to generate crude a crude ester stream that is furhter purified to generate high-purity butyl acrylate. This report was developed based essentially on the following reference(s): (1)

"Acrylic Acid", Ullmann's Encyclopedia of Industrial Chemistry, 7th edition (2) "Acrylic Acid and Derivatives", Kirk-Othmer Encyclopedia of Chemical Technology, 5th edition Keywords:

Propene, Air Oxidation, Propenoic Acid, Nippon Shokubai, Rohm & Haas, Dow, Esterification, Nippon Shokubai, Mitsubishi, BASF Acrylic Acid Production from Ethylene Oxide - Cost Analysis -

Acrylic Acid E71A
Methyl Acrylate from Acrylic Acid - Cost Analysis - Methyl Acrylate E11A
Process for the Anionic Polymerization of (meth)acrylic Acid Derivatives
Crosslinking Process

for Ethylene-acrylic Acid Copolymer Or Ethylene-methacrylic Acid Copolymer
Process for the Preparation of Mixed Anhydrides of Acrylic Acid and Its A-substitution Products

This report presents a

cost analysis of Methyl Acrylate production from acrylic acid and methanol The process examined is a typical esterification process. In this process, acrylic acid and methanol are esterified in a fixed-bed reactor producing Methyl Acrylate. This report was developed based essentially on the following reference(s):

Keywords: Methyl Alcohol, Lower Alkyl Acrylate, Methyl Prop-2-Enoate

This report presents a cost analysis of bio-based Acrylic Acid production from glucose syrup using a fermentation process In the process examined, glucose is fermented to produce 3-hydroxypropionic acid

(3-HPA), which is dehydrated to produce Acrylic Acid. The process uses a 70 wt% glucose-water syrup as raw material and the final product obtained is Glacial Acrylic Acid. This report was developed based essentially on the following reference(s): (1) US Patent 9428778, issued to Cargill in

2016 (2) US Patent 7186856, issued to Cargill in 2007
Keywords: Dextrose, Fermentation, Salt-Splitting, 3-HP, Dehydration, Glacial Acrylic Acid
This report presents a cost analysis of Ester-Grade Acrylic Acid (EAA) production from chemical grade (CG) propylene The process

examined is a typical propylene oxidation. In this process, propylene passes through a two-stage vapor phase oxidation to generate an acrylic acid-containing gas, from which acrylic acid is recovered via absorption in water. The aqueous acrylic acid solution is purified via light solvent extraction to Ester-grade Acrylic

Acid (EAA), which is used in the production of acrylic esters. This report was developed based essentially on the following reference(s): "Acrylic Acid", Ullmann's Encyclopedia of Industrial Chemistry, 7th edition Keywords: Propene, Air Oxidation, Propenoic Acid, Nippon Shokubai, Rohm & Haas, Dow

Reactive distillation for production of n-butyl acrylate from bio-based raw materials

Acrylic Acid and Esters

Bio-Acrylic Acid Production from Glucose - Cost Analysis - Acrylic Acid E31A

Process for the Quasi-ionic Polymerziation of Acrylic Acid Derivatives

The presence of acrylic acid

(AA) in process water is the major problem in many industries which are using acrylic acid. There is no proper method available to remove acrylic acid from process water and hence the industries

incinerating the process water containing acrylic acid to remove it. But, this method consumes large amount of natural gas and in turn leads to high energy consumption and high costing. This research

was attempted to remove acrylic acid via batch adsorption process by using alumina. The process water taken from BASF Petronas Chemicals Sdn Bhd containing 4% acrylic acid is used as sample water in

this study. The adsorption capacity was tested by varying different temperature, amount of alumina and contact time. The initial and final concentration of acrylic acid was

tested using High performance liquid chromatography (HPLC). The performance of adsorption process is modeled using two types of adsorption isotherms namely, Langmuir isotherms and

Freundlich isotherm. From the experimental results it was found that the alumina was good in removing AA from process water and Freudlish isotherm describe the process well compared to

Langmuir isotherms. This report discusses continued efforts to improve the process for making NFPA-acrylic acid copolymers and to characterize the product. Particular

emphasis is directed toward developing, experimentally testing, and utilizing mathematical models of the process. The scope of the work includes considerations of compositional uniformity,

molecular-weight distribution, and polymerization rate of the copolymer. A new process whereby the comonomers are added incrementally is described which greatly increases the productivity of

the reactor and permits control of molecular weight. Propellant made from copolymer prepared in this manner has improved physical properties, fissuring characteristics, and physical-

property aging characteristics. (Author).
This report presents a cost analysis of Ester-Grade Acrylic Acid (EAA) production from acetylene and carbon monoxide. The process examined involves the

addition of carbon monoxide to acetylene using a nickel carbonyl catalyst. This report was developed based essentially on the following reference(s): Keywords: BASF, Reppe Reaction, CO, Ni(CO)4

Source Assessment, Acrylic Acid Manufacture Acrylic Acid Production from Glycerol – Cost Analysis – Acrylic Acid E21A Petrochemical Processes.... State of the Art Copolymers of

Ethylene with (meth)acrylic Acid Alkyl Esters, Process for Their Production and Their Use in Damping Compositions

This report presents a cost analysis of Glacial Acrylic

Acid production from Crude Acrylic Acid. The process examined consists of a typical crystalliza tion/purification process. This report was developed based essentially on the following reference(s):

"Acrylic Acid and Derivatives", Kirk-Othmer Encyclopedia of Chemical Technology, 5th edition

Keywords: Propenoic Acid, Commercial Grade Acrylic Acid, Propylene Oxidation, BASF,

Sulzer, GAA The project showcases the preliminary design of a process for the production of acrylic acid in details. Acrylic acid is produced via the oxidation of acrolein; acrolein is

produced in the first reactor via the oxidation of propene. A comprehensive analysis of the reaction kinetics is done.The analysis is based on several technical publications that describe the

kinetics for an industrial sale process. The main objective is to design MOFIN Chemicals that produces acrylic acid at a production rate of 60,000 ton/yr. Further, the purity of the final product matched

the desired purity of 99.5%. Moreover , the process simulation is optimized using various engineering principles such as chemical engineering heuristics.The feed to the first

reactor vessel is composed of air, steam, and propene. The inlet conditions to both of the reactors are optimized in order to obtain the highest economic conversion rates possible within

several boundaries. The second reactor effluent is then sent through a series of distillation columns in order to obtain a recovery of acrylic acid of 99.9% and a purity of 99.5%.

Furthermore, as part of the project scope, both preliminary designs and detail-oriented designs are completed for the entire units of the process in order to represent a realistic process. Furthermore,

hazard analysis is completed to maintain and control a safe environment within the plant. Moreover, market analysis is done as a business model in order to determine the viability of

MOFIN Chemicals L.L.C and its organizational structure. Further, economic studies and analysis are conducted in order to determine the cost associated with the plant

and to further optimize the individual units in the process. Additionally, since both of the reactors are highly exothermic, heat integration loops are implemented in order to control both of

the reactors as well as to utilize that energy within the process. This energy is then transferred through cooling mediums to boiling feed water; BFW then becomes steam and is utilized to

transfer its latent heat across the reboilers. These integrated loops are done in order to cut down on utility costs and make the plant more economically viable.
This report presents a cost

analysis of Ester-Grade Acrylic Acid (EAA) production from propane The process examined is a novel process for propane oxidation. In this process, propane is fed to an oxyde hydrogenation reactor in the

presence of steam to form propylene. The pr opylene-containing gas passes through a two-stage vapor phase oxidation to generate an acrylic acid-containing gas, from which acrylic acid is

recovered via absorption in water. The aqueous acrylic acid solution is purified via light solvent extraction to Ester-grade Acrylic Acid (EAA). This report was developed based essentially on the

following reference(s): (1) "Acrylic Acid and Derivatives", Kirk-Othmer Encyclopedia of Chemical Technology, 5th edition (2) US Patent 6492548, issued to Union Carbide in 2002 Keywords:

Propene, Air Oxidation, Propenoic Acid, Nippon Shokubai, Rohm & Haas, Dow

Process for Producing Ethylene-ethyl Acrylate-acrylic Acid Polymer

Bio-Acrylic Acid Production from

Raw Sugar - Cost Analysis - Acrylic Acid E41B

Bio-Acrylic Acid Production from Glucose - Cost Analysis - Acrylic Acid E32A

The Design of MOFIN Chemicals for the Production of 60, 000 Tons/yr of

Acrylic Acid with a Purity of 99.5%

Acrylic Acid Production from Acetylene - Cost Analysis - Acrylic Acid E61A

This report presents a cost analysis of bio-based Acrylic Acid production from raw sugar using a fermentation process.

The process examined is similar to Cargill process. In this process, raw sugar (sucrose) is diluted and sucrose is hydrolyzed into glucose and fructose (invert sugars). The invert sugars are then fermented to produce 3-hydroxypropionic acid (3-HPA), which

is dehydrated to produce Acrylic Acid. The final product obtained is Glacial Acrylic Acid. This report was developed based essentially on the following reference(s): US Patent 20140364643, issued to Cargill in 2014 Keywords: Dextrose, Anaerobic

Fermentation, Salt-Splitting, Tridecylamine, Propenoic Acid

This report presents a cost analysis of Ester-Grade Acrylic Acid (EAA) production from crude glycerol

The two-step process examined is similar to Arkema process. In this process, crude

glycerol (at 85 wt% purity) obtained as by-product of biodiesel plants, is used as the main raw material. After purification, glycerol is dehydrated to acrolein and subsequently oxidized. The final product obtained is EAA, which is used in the production of

acrylic esters. This report was developed based essentially on the following reference(s): US Patent 2010/0168471 A1, issued to Arkema in 2010 Keywords: Glicerin, Dehydration, Oxidation, Unsaturated Carboxylic Acid, Propenoic Acid

This report presents a cost analysis of bio-based Acrylic Acid production from raw sugar using a fermentation process. The process examined is similar to the speculative process proposed by the Delft University of Technology. In this process, a biological

agent is able to convert raw sugar (sucrose) to acrylic acid through an anaerobic metabolic pathway. The final product obtained in the process is Glacial Acrylic Acid. This report was developed based essentially on the following reference(s):

Straathof, A. et al., "Feasibility of Acrylic Acid Production by Fermentation", Applied Microbiology Biotechnology, 2005, 67:727-734

Keywords: Bioacrylic Acid, Propenoic Acid, Anaerobic Fermentation, Unsaturated Carboxylic Acid,

Green Acrylic Acid, Renewable Feedstock
A Process for the Production of Acrylic and Methacrylic Acid Esters
Catalysis in Petrochemical Processes
Acrylic Acid Production from Propane - Cost Analysis - Acrylic

Acid E91A
Glacial Acrylic Acid from Crude Acrylic Acid - Cost Analysis - Acrylic Acid E51A
Catalyst Deactivation Study of the Esterification of Dilute Acrylic Acid with Different Concentration Catalyzed by Ion Exchange Resin

Publisher Description

Acid-catalysed esterification of acrylic acid with 2-ethylhexanol is the principal method for the manufacture of 2-ethylhexyl acrylate.

2-ethylhexyl acrylate is a clear,

water-white liquid with a sweet odor and is readily miscible with most organic solvents, but has negligible solubility in water. In chemical industry, 2-ethylhexyl acrylate is primarily used as a reactive building

block to produce polymer coating, adhesives and sealants and it can be polymerized itself. In addition, improving the water resistance, weather ability and sunlight resistance of final product can be made in presence

of acrylic acid. Industrial waste water generally can be described as the water or liquid carries waste from industrial or commercial processes. The spent water (wastewater) may contain a large

variety of organic compound such as acrylic acid, formaldehyde, acetic acid and more but acrylic acid dominate the amount in polymer industrial wastewater that could harm the aquatic organisms. Currently,

incineration treatment method is neither environmental friendly and nor economical. So, reactive distillation in esterification process has potential to recover the acrylic acid in the industrial waste

water. In this study, the esterification of dilute acrylic acid with 2-ethyl hexanol that catalyzed by ion exchange resin have been carried out. The objective of the present study was to investigate the

deactivation of Amberlyst 15 in the esterification of dilute acrylic acid.

Homogeneous catalyst have some limitations such as catalyst recovery problem, disposal of toxic wastes formed during reactions,

separation of the products, and loss of catalysts that can cause the solid acid catalyst will be choosen in this study. The esterification p rocess have been conducted in presence of Amberlyst 15 as a catalyst and

Phenothiazine as polymerization inhibitor under certain conditions. The range of water content in the dilute acrylic acid have been varied and as well as the presence of inhibitor. The catalyst activiy have been

characterized to examine the morphology for fresh and used catalyst after the reaction. Another testing wasto determine the catalyst compositions, to check the functional group of catalyst and to

determine the measurement for its surface area. From the result, catalyst deactivation happened as increase in water content for diluted AA in the reaction mixture. The present study show that more

water content needed to dilute AA solution and more polymerization inhibitor to prevent the polyacrylic acid formation in the reactions.

This report presents a cost analysis of Ester-

Grade Acrylic Acid (EAA) production from crude glycerol. The two-step process examined is similar to Arkema process. In this process, crude glycerol (at 85 wt% purity) obtained as by-product of biodiesel plants, is

used as the main raw material. After purification, glycerol is dehydrated to acrolein and subsequently oxidized. The final product obtained is EAA, which is used in the production of acrylic esters. This

report was developed based essentially on the following reference(s): US Patent 2010/0168471 A1, issued to Arkema in 2010 Keywords: Glicerin, Dehydration, Oxidation, Unsaturated

Carboxylic Acid, Propenoic Acid
Acrylic Acid Production from Propylene - Cost Analysis - Acrylic Acid E11A
Butyl Acrylate Production from Acrylic Acid and Butanol - Cost Analysis - Butyl Acrylate E11A

Ethyl Acrylate from Acrylic Acid - Cost Analysis - Ethyl Acrylate E11A
Glacial Acrylic Acid from Crude Acrylic Acid - Cost Analysis - Acrylic Acid E52A
Industrial Organic Chemicals