Simulation of Process Equipment by using Hysys

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ABSTRACT
HYSYS is a software program used for simulation of chemical process. It is a market-leading process modeling tool for conceptual design, optimization, business planning, asset management, and performance monitoring. Due to its accuracy it is widely used in industries such as oil & gas production, gas processing, petroleum refining, and air separation industries. Study shows the advantages of hysys and why it is preferred over other softwares. This work gives introduction of working of hysys in various chemical fields. Study also involves application of Hysys with devices or equipments such as pumps, compressors and heat exchanger.

Keywords – Aspen-HYSYS , Controllers ,Dynamic simulations , , PFD, Steady state.

I. INTRODUCTION

1.1 Simulation

Simulation is an situation in which a particular set of conditions is created artificially in order to study or experience something that could really exist in reality. It is the act if pretending that something is real when it is not. A computer simulation is an attempt to model a real-life or hypothetical situation on a computer so that it can be studied to see how the system works.

1.2 Simulation Modes:-

There are two modes of simulation- Steady state mode and Dynamic mode.

1.21 Steady State Mode:

Initially process simulation was used to simulate steady state processes. Steady state models perform a mass and energy balance of a stationary process(a Process in an equilibrium state) but any changes over time had to be ignored.

1.22 Dynamics Mode:

Dynamic simulations require increased calculation time and are mathematically more complex than a steady state simulation. It can be seen as a multiply repeated steady state simulation(based on a fixed time step) with constantly changing parameters.

1.3 Process Simulators:-

- Aspen Plus, Aspen Hysys, Aspen Custom Modeler by Aspen Technology.
- CHEMASIM.
- CHEMCAD.
- ProSimulators by Sim Infosystems.
- ProSinPlus by ProSim.

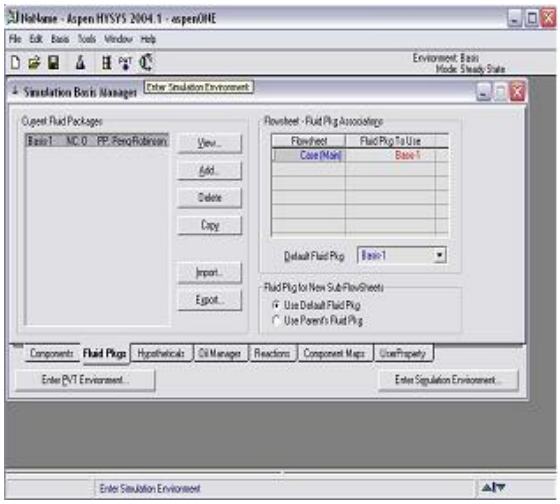
1.4 HYSYS

Aspen HYSYS is a market leading process modelling tool for conceptual design, optimization, business planning, asset management and performance monitoring for oil n gas processing, petroleum refining, and air separation industries. Aspen HYSYS is a core element of AspenTech's aspenONE Engineering applications. Aspen HYSYS has established itself as a very intuitive and easy to use process simulator in oil and gas refining industry. Users with little prior knowledge of Aspen HYSYS can pick up and train themselves in its modelling capabilities. Some of the very intuitive capabilities include a highly interactive process flow diagram for building and navigating through large simulations. The program also provides a very flexible and easy to use distillation column modelling environment. Additionally the interactive nature of HYSYS enables users to build and use their models quickly and effectively. Aspen HYSYS offers a comprehensive thermodynamics foundation for accurate calculation of physical properties, transport

properties, and phase behaviour for the oil & gas and refining industries. Comprehensive library of unit operation models including distillation, reactors, heat transfer operation, rotating equipments, controllers and logical operations in both the steady state and dynamic environments.

2. Description:-

Before any simulation occurs Hysys needs to undergo an initial setup. During an initial setup, the components and fluid packages to be used should be selected. New simulation profile is created where sim name and formula is entered. While making the PFD material streams are specified and entered.



By knowing the specific volume with the help of equation of state we can determine the size and thus cost of the plant. Hysys offers Peng Robinson (PR) and Soave Redlich Kwong (SRK) equation of state. Of these the Peng Robinson equation of state supports the widest range of operating condition.

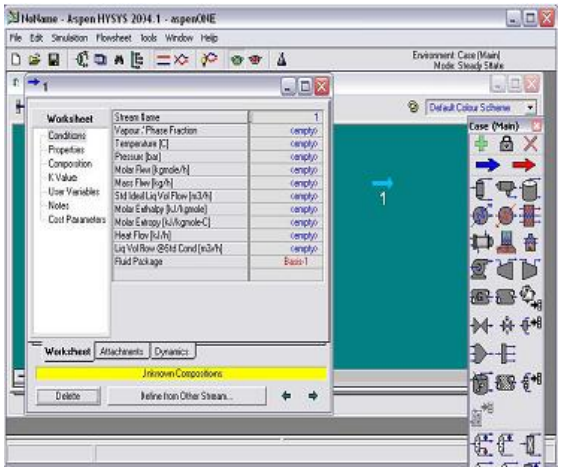


Fig: 2.1 Aspen Hysys Screen

2.1 Working with basic equipments

2.1.1 Working with Pump:-

The pump operation is used to increase the pressure on inlet liquid stream. Depending on the information specified, the pump calculates either an unknown temperature, pressure or pump efficiency.

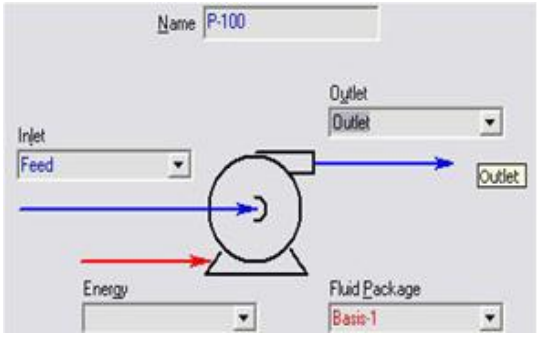


Fig:2.2 Contacting Pump with streams

2.1.2 Working with Compressor:-

The compressor operation is used to increase the pressure on inlet gas stream. Depending on the information specified, the compressor calculates either a unknown temperature, pressure or compressor efficiency.

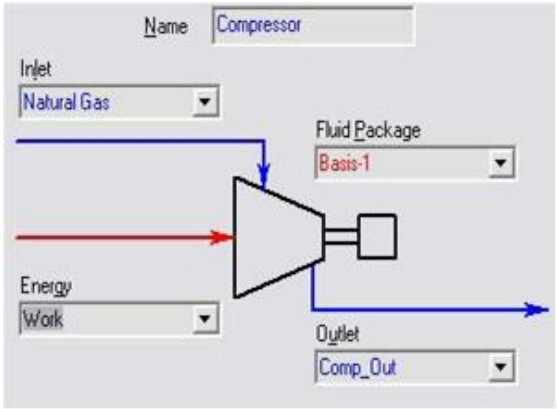


Fig:2.3 Contacting Compressor with Streams

2.1.3 Working with Heat Exchanger:-

The Heat Exchanger performs two sided energy and material balance calculations. The Heat Exchanger is very flexible and can solve for temperature, pressure, heat floes (including heat loss and heat leak), material streams.

In Hysys Heat Exchanger model can be selected and either of the parameters or flow rates are mentioned to obtain another. This can be done in steady state as well as in Dynamic mode of simulation.

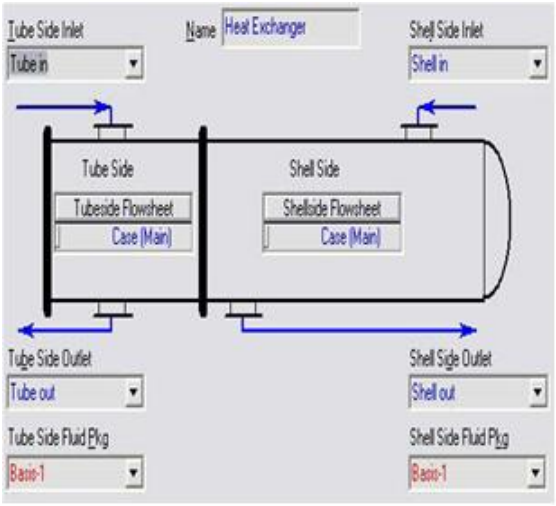


Fig: 2.4 Connections of Streams.

2.1.4 Working with various columns:-

This includes working with distillation, absorption and also separation columns. The needed output,

available input conditions and parameters such as pressure, compositions are provided. Simulator itself then comes out with solutions such as temperature desired to carry out the process.

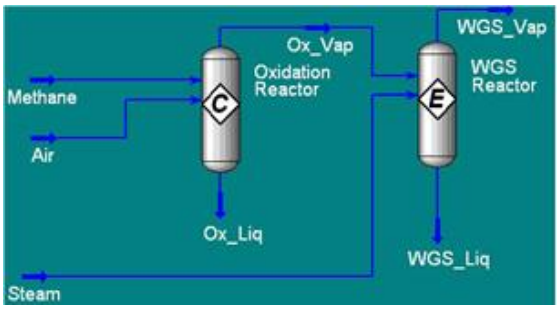


Fig: 2.5 Model for Water gas Shift Reaction

The list of equipments continues from the expanders, various reactors and CSTRs. Hysys supports provision for maximum equipments used in carrying out unit operations.

2.2 Case Study:-

It was at the Preemraff Refinery where the company recently controlled its Propeylene/ Propane (PP) splitter, which is used to separate C3 streams into 99.5% pure chemical – grade propylene and 98.5% pure propane. Any deviations in quality could affect Preem's profitability since there is a high market value for pure propylene.

Instead of using live plant step tests to develop a model-predictive controller for the PP splitter, Preem's engineer team used Aspen Hysys to integrate rigoros simulation models of the PP splitter with the Aspen DMC plus process controller. Once online, this innovative, Hysys – enhanced controller helped reduce propylene variation bu 50% saving Preem more than $55K a year. In addition, the same models were leveraged for operator training simulators to improve plant performance.

2.3 Economics:-

The cost of this software is approximately $45,000 for the dynamic version and $20,000 for the steady state version. As compared to the pilot plant it is almost half of the minimum expected

2.4 Example

Toluene is produced from n-heptane by dehydrogenation over a Cr_2O_3 catalyst:

$$CH_3CH_2CH_2CH_2CH_2CH_2CH_3 \rightarrow C_6H_5CH_3 + 4H_2$$

The toluene production process is started by heating n-heptane from 65 to 800°F in a heater. It is fed to a catalytic reactor, which operates isothermally and converts 15 mol% of the n-heptane to toluene. Its effluent is cooled to 65°F and fed to a separator (flash). Assuming that all of the units operated at atmospheric pressure, flow rates in every stream leveraged for operator training simulators to improve plant performance.

3. Conclusions:-

The goal of Hysys is to provide a capability to design an entire process completely and accurately.

3.1 Advantages of Aspen Hysys:

1. Aspen Hysys provides an extremely powerful approach to steady state modeling.
2. Aspen Hysys approach to modeling maximizes return on simulation time through increased process understanding.
3. Aspen Hysys offers a comprehensive thermodynamics foundation for accurate calculation of physical properties, transport properties, and phase behaviour and newer versions of Hysys have almost doubled in its capabilities on physical properties.
4. Aspen Hysys introduced the novel approach of steady state and dynamic simulations in the same platform. It has became the defacto standard in industry, and today enjoys universal acceptance.
5. Aspen Hysys let process engineers estimate the Green House Gas Emissions associated with a process.
6. Refinery Reactor Technology which includes Fluidized Catalytic, Hydrocracking and Hydrotreating, Reforming and Isomerisation enables Aspen Hysys to perform single unit, multi unit as well as refinery wide simulations.

3.2 Limitatons:-

1. Unlike Aspen, Hysys does not wait until you have entered everything before beginning calculations. It always calculates as much as it can at all time and results are always available even during calculations. Any changes made to the data are automatically propagated throughout the program to anywhere that entry appears and all necessary recalculations are instantly carried out. This creates a problem when there is no need for calculating the entire flowsheet over again every time whenever there is small change.
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3.3 Applications:-

Hysys is applied in industry for simulation of:

1. Acid Gas Sweetening with DEA (Diethanolamine).
2. Atmospheric Crude Tower.
3. Sour Water Stripper.
4. Propylene/Propane Splitter.
5. Ethanol Plant.
6. Synthesis Gas Production.
7. Petroleum Industry.

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REFERENCES:-

[1] Mohd.Kamaruddin Abd Hamid "Hysys: An introduction to Chemical Enginnering Simulation".
[2] Michael E Hanyak "Chemical Process Simulation and Aspen tech Hysys Software" Version 2006 Bucknell university Lewisburg PA 17837 December 15 2007.
[3] Aspen Hysys Customization Guide, 2005.
[4] Aspen Hysys@ 2004.2 Dynamic Modeling.[5] Issues addresses by Process Modeling (Aspen Hysys) V7.2 Cumulative patch 2, September 2010.
[5] Rijo Jacob Thomas "Thermodynamic Analysis of Collin's Cycle: Aspects of Designing Large scale Helium Liquifiers" Journal – Proceedings of International Cryogenic Engineering Confrence, ICFC23, 2010.
[6] Design Modeling and simulation of air liquefaction by John E. Crowley, School of Aerospace Engineering Space Systems Design Lab Georgia Institute of Technology, 2007.