Pilot plant description

The unit consists of two fixed bed reactors (18"x 1.1"i.d.) which can operate in series for up or down flow. The reactors are capable of operating at temperatures up to 550 °C and pressures up to 150 atm. The reactor feed system includes three independent gas feed modules and one liquid feed module with all necessary equipment. The preheated liquid feed is introduced to the reactors with a diaphragm pump equipped with an electrically heated pump head. The two reactors can be operated as two phase fixed bed reactors or trickle bed reactors.

The reactors outlet is cooled by a double pipe cooler and is led to a separator where the gas and liquid parts are separated. The liquid product from the separator bottom passes through a level control valve (for keeping the separator level constant) and is collected in a heated vessel located on a weigh scale. The gas exit from the separator passes through a pressure control valve which maintains the required reactor pressure. A bypass is installed for atmospheric operation of the installation. The outlet vent is connected to a wet test meter to measure the outlet flow of the system.

The pilot plant can operate at very high pressures and high temperatures.

Specification of the Pilot Plant

Reactors	2 in series
Catalyst Volume	max 210 cc/reactor
Temperature	max 550°C
Temperature of Liquid Feed/Liquid Product	max 150°C
Gas 1 flow rate	100-1000 Nl/hr
Gas 2 flow rate	30-300 Nl/hr
Gas 3 flow rate	47-470 Nl/hr
Feed vessel	20 l
Product vessel	20 l
Pretreatment catalyst vessel	5 l

It must be pointed out that since the unit can carried out high pressure and high temperature processes even using explosive gases (hydrogen), the unit has a very integrated and accurate safety and alarm system. The pilot plant unit is

fully automated by the means of a dedicated computer control system. All the control strategy is executed on a process computer. The computer system will be described later.

Applications of Pilot Plant

The unit has already been applied for the hydrodesulfurization of a petroleum fraction. Hydrodesulfurization is one of the most important refinery process since it can remove completely or decrease the sulfur, nitrogen and organic oxygen contents of a petroleum fraction. The process also causes saturation of the double bonds and at high pressures and temperature it may lead to the breaking of carbon-carbon bonds giving thus lower molecular weight products. As liquid feed it was used diesel, from a Greek refinery (EKO), with 0.75 %wt sulfur content and as gas feed hydrogen. The hydrotreating has taken place at 30 bar and at 350°C. During the operation both of the reactors were on line ant they contained CoMo type catalyst. The operation of the unit was satisfactory for a 15 days run. The desulfurization achieved was 96.5% From this work it became clear that the unit is satisfactory for the evaluation of existing and new catalysts and for the determination of more suitable operating conditions for the various hgydrotreating processes.

Control System Application Capabilities

The control system hardware is based on a network of three computers. One 486-technology PC and two special data acquisition computers by analog Devices (mMAC-1050). These computers have special signal ports that are connected to the process sensors and instruments. The special software that is performing all process automation and control operations is the FIX/DMACS by *Intellution*. Based on this software the unit includes high degree of automation.

The structure of the software is such that the selection of operating conditions is altered easily by the operator at any given moment. By the use of special programming modules the time scheduled operation and automatic operating conditions variation are easily implemented. Novel control algorithms can also be included in the software that act on the output signals as well as supervisory control techniques acting on set points of existing digital PID controllers. Additionally the operation of the unit can be carried out in parallel to the execution of

the on-line process models and/or the application of novel control algorithms of signal processing filtering and control are also possible like Kalman filter, non-linear control etc