EXAMPLES OF THE USE OF PILOT PLANTS TO OBTAIN ENGINEERING AND ECONOMIC INFORMATION NEEDED FOR PROCESS INDUSTRIALIZATION (*)

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The author's experience has not been very closely related to the metallurgical industry. However, it has encompassed the pilot plant development of several processes and equipment in broad use in the petroleum refining industry. This paper will present some principles applicable to pilot plant developments generally and will cite various pilot plant developments in the author's experience to illustrate methods of attack, new engineering techniques discovered, and utilization of pilot plant data in economic assessment and industrial scale plant design. Since most of the illustrations are from process developments relating to petroleum refining, attention will be focussed on mechanical features, handling of materials and heat control (which are more closely related to metallurgical developments) rather than to variables affecting the chemical reactions in petroleum refining.

Pilot plants are built and operated for a number of valid reasons; among these are (1) to explore changes in operating conditions in existing processes where experimentation in industrial plant equipment is not feasible; (2) to develop new equipment for existing processes; (3) to develop new processes; and (4) even to convince top company management that a new process or proposal is sound.

After a new process method has been discovered in a research laboratory or a new idea has been conceived for processing material in, hopefully, a better and more economical manner, there always exists the desire to put this to industrial use. The question now arises as to whether a pilot plant should be built, and if so, what size and how complex.

Of course, no categorical answer can be given to this question. Each new case must be studied individually to determine what new information must be obtained for use in designing an industrial plant, and to determine whether some or all of the new information can be computed or obtained in a small bench scale unit. Seldom is it necessary to build a full-fledged integrated pilot plant. The better approach is to establish which part or parts of the new process or technique cannot be computed, and to investigate these parts separately in mock-up models. Also, in some instances it is desirable that the geometry of the pilot plant be similar to that of the conceived industrial plant, but in most instances this is not true. The important consideration is that the pilot plant data may be extrapolated with reasonable accuracy into the industrial size.

The above observations and comments are described in the following eight examples of pilot plant developments:

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Example 1. Use of Molten Heat Transfer Salt to Control Temperature in Catalytic Cracking Units.

Example 2. Kiln for Regenerating Fullers Earth

Example 2. Continuous Moving Bed Catalytic Cracking

(a) Durability of Catalyst

(b) Feeding Catalyst into a Pressure Vessel

(c) Device to Ensure Uniform Flow of Catalyst Through Vessels.

(d) Withdrawal of Granular Catalyst from a Pressure Vessel

(e) Removing the Heat of Combustion from the Catalyst in the Regenerator Kiln.

Example 4. Apparatus for Drying Clay Catalyst Pellets

Example 5. Pilot Plants Used in the Development of Synthetic Cracking Catalyst

(a) Forming the Beads

(b) Washing the Beads

(c) Drying Beads

(d) Heat Treating Beads

Example 6. Lifting Catalyst by Entrainment in a Stream of Air

Example 7. Retorting of Oil Shale

Example 8. Catalytic Reforming of Petroleum Naphtha.

The examples illustrate the types of problems that may be encountered in pilot plant work, and indicate what type and size of pilot plant is needed to obtain reliable data for use in industrial plant design. Depending on the problem, the pilot plant may vary from a simple unit, representing a small segment of a contemplated commercial installation, to a large pilot plant capable of operating under industrial conditions.

Following are a few of the things that one should not do in pilot plant development:

(a) Do not clutter up a pilot plant with a lot of auxiliary equipment just to duplicate full-fledged industrial operation. It slows down results and generally contributes nothing.

(b) Do not build a pilot plant of the same geometry as the contemplated industrial plant and expect the pilot plant data to extrapolate to industrial performance. Too many things such as linear velocity, pressure drop, and heat transfer rate change with size.

(c) Do not try to build a pilot plant out of the materials of construction contemplated for the industrial plant. Study corrosion in separate equipment and with test samples in the pilot plant.

(d) Do not build a pilot plant to investigate things that can be learned in smaller bench scale equipment. Data are obtained faster and cheaper in the smaller equipment.

(e) Do not build a pilot plant to obtain answers that can be computed with confidence from existing information.

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