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FARMLAND HYDRO L.P. INCREASES EFFICIENCY WITH 495 T/D ADDITIONAL PHOSPHORIC ACID EVAPORATOR CAPACITY

ELIMINATING SEAL WATER INCURSION HAS POTENTIAL TO DEFRAY INITIAL COST OF 750 MM SIZE ELBOW TYPE EVAPORATOR PUMP

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RESUME

En septembre 1991, Farmland Hydro L.P. (FHLP) a perçu le besoin d'augmenter la capacité de l'évaporateur d'acide phosphorique pour concentrer 495 t/j de P_2O_5 de 40 à 54 %.

Utilisant la propre expérience de FHLP, Phosphate Engineering Co. a mis au point le principe du procédé. L'ingéniérie mécanique du procédé et la construction ont été effectuées par Case Engineering Co. Les deux sociétés se trouvent à Lakeland, Floride. Le projet a été réalisé et réceptionné avec des résultats remarquables en mai 1992, se conformant étroitement au programme de six mois du projet.

En éliminant l'incursion d'eau à travers les joints dans le P_2O_5 en cours d'évaporation, des économies significatives et un rendement accru de production peuvent être réalisés lorsque la nouvelle pompe de circulation de l'évaporateur de FHLP est modifiée du dispositif avec boîte remplie vers l'opération d'un joint mécanique.

Le coeur du système d'évaporateur de P_2O_5 est une pompe d'évaporateur (du type à coude) à flux axial Lewis de 750 mm, type LH-60430, réglée pour un débit de 5480 m^3/h (24.100 USGPM). La pompe comporte un dispositif avec arbre/support pilotés avec précision qui permet l'emploi de joints mécaniques à faible jeu pour éliminer effectivement l'incursion d'eau de joint dans le P_2O_5 en cours d'évaporation.

Tous les producteurs expérimentés de P_2O_5 le reconnaissent, l'incursion d'eau de joint est un facteur significatif qui peut coûter plus que le coût initial de la pompe de circulation d'évaporateur pendant une certaine période. Ainsi, l'installation pompe/joint peut s'amortir elle-même.

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BACKGROUND

Farmland Industries is one of the largest regional farm cooperatives in the United States. Headquartered in Kansas City, it serves thousands of members in 19 Midwest states. Products are sold domestically and internationally. Farmland was founded in 1929 to obtain the cost benefits of large-scale purchases of fertilizer and petroleum products for its members. Manufacture of these products soon followed to further minimize member costs. Other activities now include manufacture of pork products, farm animal and pet foods, and miscellaneous services to members such as management techniques and financial services.

To provide a reliable supply of phosphate fertilizer to its members at an economical cost, Farmland operates a "world-class" phosphate fertilizer complex at Green Bay, Florida. Please see **Figure 1** which shows an aerial view of this facility.

Figure 3: Flotation Flowsheet

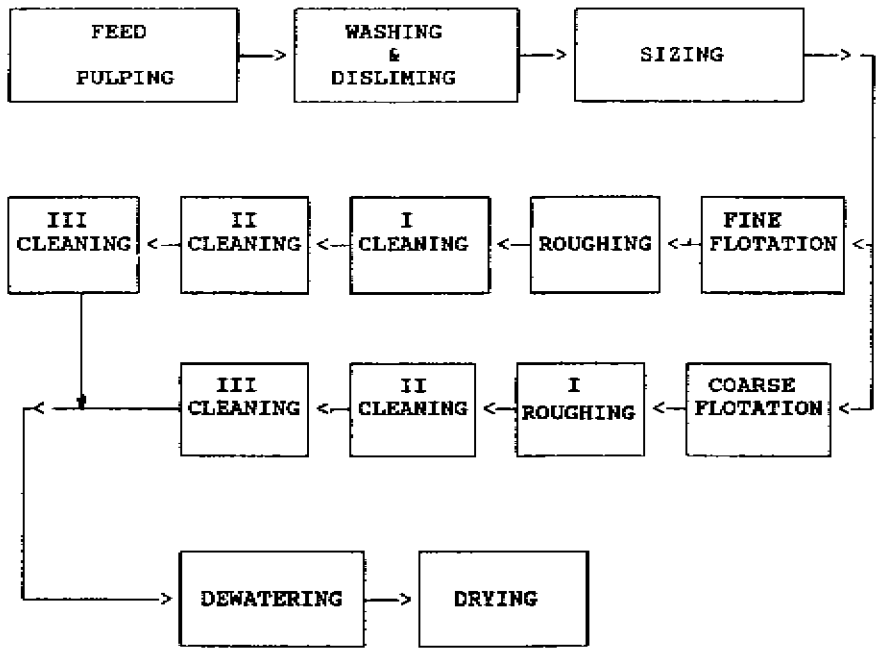
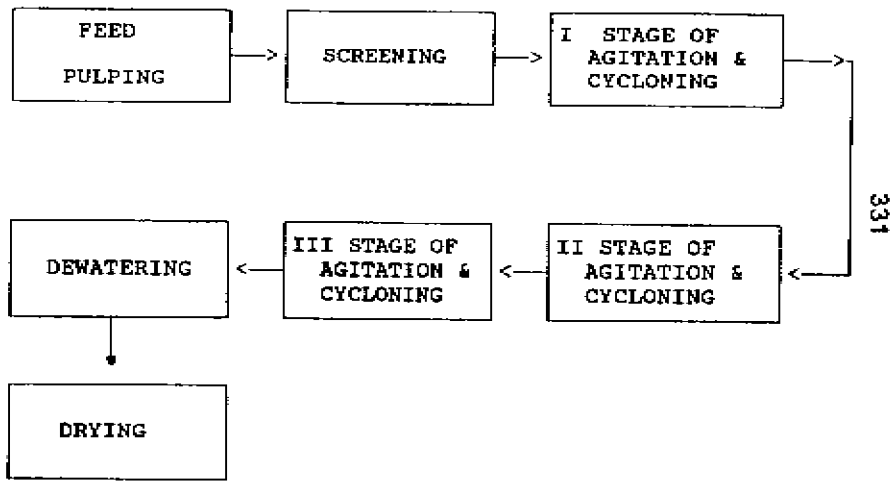


Figure 4: Washing and disliming flowsheet



In November of 1991, Norsk Hydro of Oslo, Norway became a joint venture partner with Farmland Industries in the Green Bay Plant. Norsk Hydro is a leading manufacturer and marketer of fertilizer in over 100 countries of the world. Norsk Hydro's other activities include petroleum production and refining, aluminium and magnesium production, ocean farming, and other business ventures.

PROJECT SCOPE

In September 1991, Farmland completed the planning to build additional phosphoric acid evaporator capacity to concentrate 495 STPD P_2O_5 from 40% to 54% concentration.

Drawing upon their own experience, Farmland contracted with Case Engineering Co. (Case) and Phosphate Engineering & Construction Co. (PECO) to design and build a single effect forced circulation evaporator system to increase phosphoric acid production at their Green Bay plant. Although similar in size and capacity to their existing units, Farmland included several improvements to remedy maintenance problems.

The process flows were developed by PECO. Case Engineering provided detail design, engineering, procurement, construction services as well as the installation of process vessel and the equipment items. Not only did Case supply the battery limits work, but Case Engineering also completed "tie-ins" to the existing systems.

Major equipment was purchased directly by Farmland in accordance with the evaporator package/equipment list included in **Table 1**.

EVAPORATOR CONSTRUCTION

Farmland's evaporator unit is a forced circulation vacuum unit as typically used by USA phosphate fertilizer producers. Incorporated in this traditional evaporator design are both the bottom and top liquor chambers, and the evaporator heat exchanger. The entrainment separator, the fluorine scrubber, the direct contact barometric condenser and a two (2) stage steam jet vacuum ejector set top off the conventional vertical stack arrangement. Of course, the main evaporator circulating pump and the product/drain transfer pump constitute the critical rotating machinery components of this system. **Figure 2** shows a photograph of the vertical stack arrangement, which is dictated by the extremely limited plant space. Sufficient space for a side-by-side installation is simply not available. **Figure 3** shows a schematic flow diagram of the evaporator.

PHOSPHORIC ACID ALLOYS - CORROSION

Pure phosphoric acid is only mildly corrosive and the more common stainless steel alloys provide adequate corrosion resistance. However, wet process phosphoric acid is generally quite corrosive due to the presence of numerous impurities, the most detrimental being fluorine and chlorine. Product acid corrosiveness is dependent upon the ore source and the resultant impurities. Phosphoric acid is normally produced at strengths of approximately 30% P_2O_5 and 42% P_2O_5, depending upon the process technology. Reaction temperatures are normally 70°C (160°F) and higher.

Chromium-molybdenum alloys are widely applied in this service. Although cast and wrought 316, 317, and Alloy 20 stainless steels have been used for many years, cast duplex stainless steels have proven to be more successful in this service. Lewmet 15, Fe-28Cr-2.5Mo-3.5Cu, was introduced in the late 1950's; chemical composition is balanced to eliminate the possibility of sigma phase, an Fe-Cr intermetallic, which causes embrittlement and a large increase in corrosion rates.

Wrought duplex stainless steel alloys are now readily available from a variety of sources. The duplex stainless steels provide the added benefit of improved abrasion resistance due to their hardness and strength, a result of the austenitic-ferritic microstructure. A variety of modified Alloy 20 type alloys are available in both cast and wrought form. Generally, these alloys have increased molybdenum content of 4.5% to 6%.

Lewmet® 25, a Ni-29 Cr-4.5Mo-3Cu alloy, was developed in the late 1970's in conjunction with a Florida producer for use in evaporator service. The alloy is fully austenitic. Corrosion rates are less than 0.1 MMY (4 MPY) in acid concentrations to 54% P_2O_5 and temperatures of 90°C (195° F), even with combined 0.5% Cl^- and 1.25% F^-. Corrosion resistance is unaffected with high operating velocities as seen in pump impeller applications.

LEWIS 30-LH EVAPORATOR CIRCULATING PUMP

The heart of the evaporation circulation system is a 750 mm Lewis Type 30-LH, elbow style axial flow pump which features a Lewmet 15 alloy propeller, elbow and a renewable Lewmet alloy casing. Specified hydraulic conditions are 5477 M^3/Hr,(24100 USGPM), flow of 40→54% P_2O_5 at a total dynamic pumping head of 4.42 MLC (14.5 feet) when operating at 410 revolutions per minute. The drive comprises a 187 KW, (250 HP), 4160 volt totally enclosed, chemical-duty, horizontal, foot mounted, 1200 rpm electric motor with a V-belt drive. Please see **Figures 4 and 5** which show the pump's construction details.

Lewis' type 30-LH axial flow propeller pump features rugged construction with heavy wall, all cast pump components of the highest integrity. Cast in Lewis' proprietary alloys, the 30-LH elbow pump has been engineered specifically to provide high efficiency, long service life and easy maintenance in phosphoric acid evaporator duty.

A one-piece precision-bored bearing housing with registered alignment to the elbow incorporates a heavy duty, double row, tapered roller thrust bearing and a large diameter shaft assembly. The rigid bearing/shaft arrangement maintains shaft deflection in the stuffing box area well within most seal manufacturers' maximum shaft runout requirements and assures long mechanical seal service life. A separate casing and elbow design facilitates easy field alignment of the pump with the drive belts in place and allows installation of a replaceable, renewable casing wearing liner.

STUFFING BOX/MECHANICAL SEAL - SEAL WATER INCURSION

Most older evaporator pump installations in the USA operate with packed stuffing boxes. Packed stuffing boxes will tolerate much greater shaft deflection than mechanical seals. The phosphate industry estimates that packed stuffing box pumps utilize as much as 20/25L/MIN (5-6 GPM) cooling water to the stuffing box area. Depending upon the condition of the pump, it is not unusual for this flow to be much higher. As much as one half of this water is introduced into the process stream.

INDUSTRY REPORTS

The cost to the operator of this water incursion cannot be emphasized too strongly: each one liter per minute of water leakage imposes an additional duty on the evaporator circuit equivalent to 40 Kw. Obviously, this represents a cost penalty which is clearly unacceptable in today's economic environment!

Taking advantage of Lewis' new, more rugged bearing frame and shaft design, several leading USA phosphate producers in Florida and Carolina as well as a major Middle East producer are testing mechanical seals to restrict the seal water incursion into the P_2O_5 process stream.

Single split mechanical seals are popular in the USA and can be installed easily without requiring disassembly of the pump. Currently two (2) major USA phosphate producers are testing split seals toward limiting incursion into the process stream to the minimum possible.

A double mechanical seal Lewis installation has been operating, ex-USA, for approximately two years with no pump or mechanical seal failures. The amount of water flowing to the seal for cooling purposes is 240 liters/hour. Seal water incursion into the process liquid is essentially zero. However, the double mechanical seal requires disassembly of the pump for installation, which is a cumbersome maintenance procedure.

TABLE 1 - EVAPORATOR PACKAGE/EQUIPMENT LIST

The evaporator package purchased by Farmland Hydro L.P. is based upon the coordinated efforts of Farmland Hydro, PECO, and CASE, and is comprised of the following:

Evaporator Circulating Pump and Motor
Ejector Set
Fluorine Scrubber
Evaporator Heater
Evaporator Body with Vortex Breaker
Entrainment Separator
Barometric Condenser
Bottom Liquor Chamber
Top Liquor Chamber
External Vapor Piping
Internal Vapor Piping
Circulating Piping
Product Overflow Manifold

The evaporator circulating pump, evaporator heater, barometric condenser, and ejector set are engineered items which were purchased directly from process equipment manufacturers.

The remainder of the evaporator package was purchased from local fabricators.

Additional items which were provided locally include:

Fluorine Scrubber Mist Eliminator
Fluorine Scrubber Spray Assembly
Circulating Piping Lump Screen
Evaporator Heater Pop Valve
Evaporator Heater Level Gauge
Evaporator Heater Insulation
Vortex Breaker Insulation
Vent Piping and Valves
Gauge Piping, Valves and Gauges

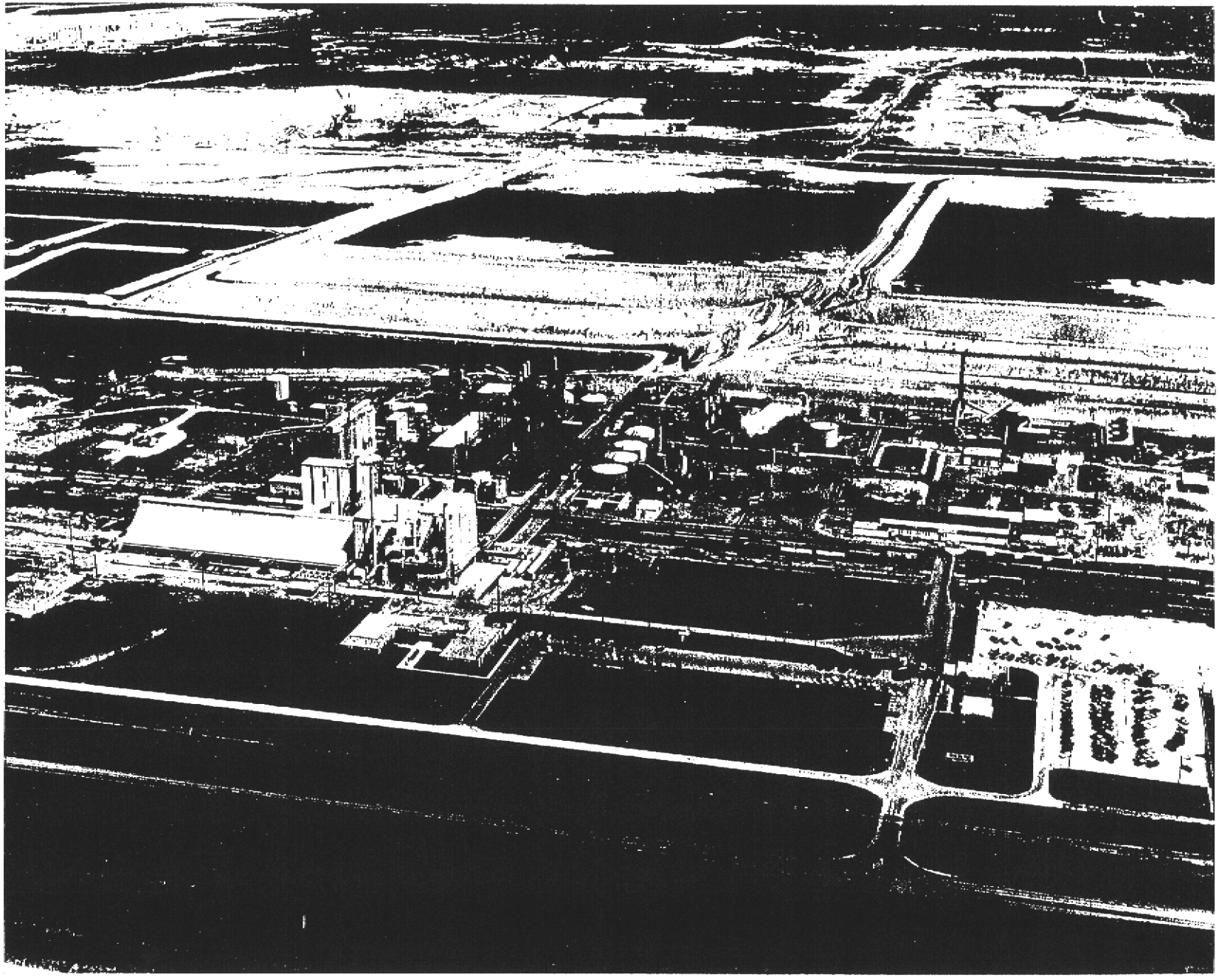


FIGURE 1 FARMLAND HYDRO, L.P.-GREEN BAY PLANT

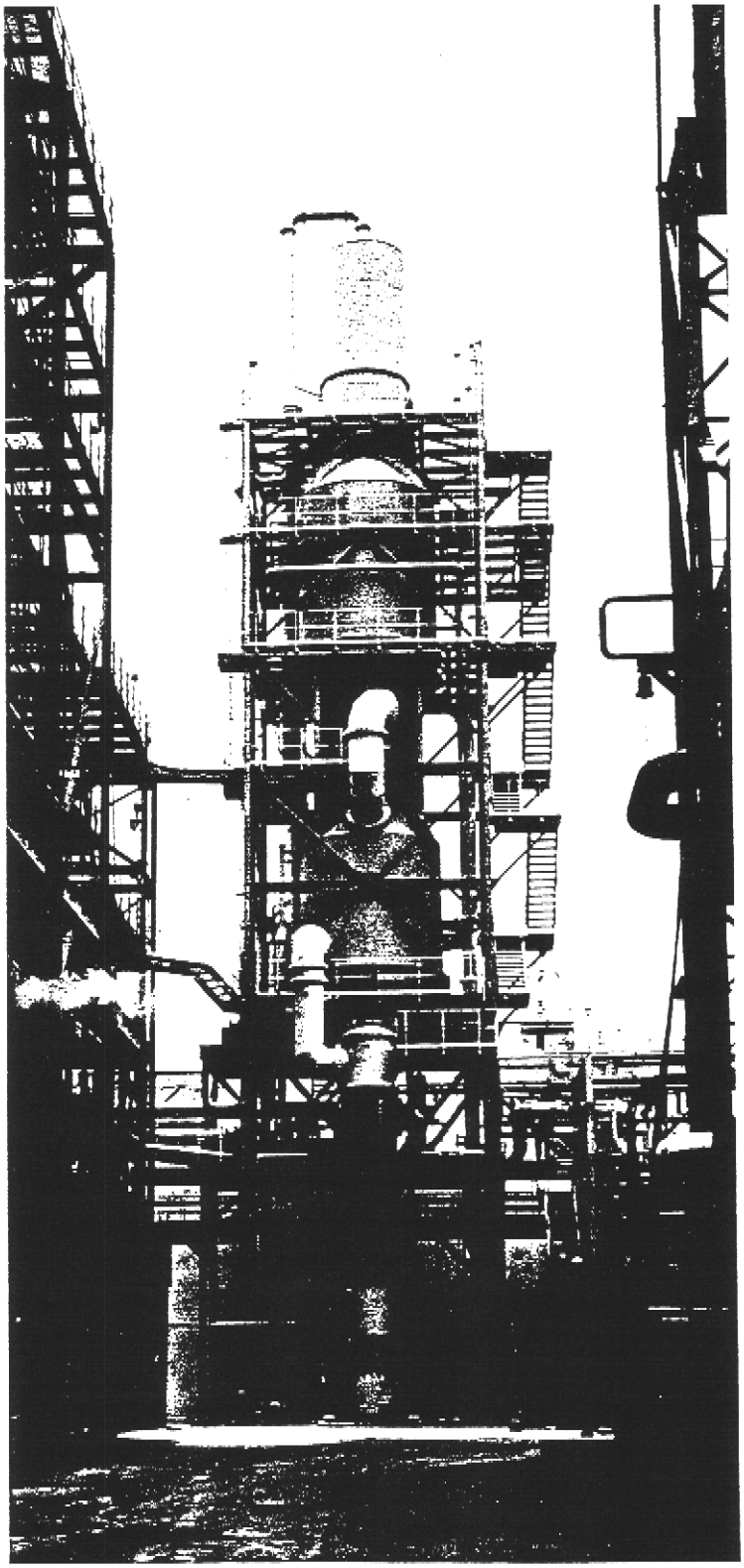


FIGURE 2 FARMLAND HYDRO VERTICAL EVAPORATOR STACK

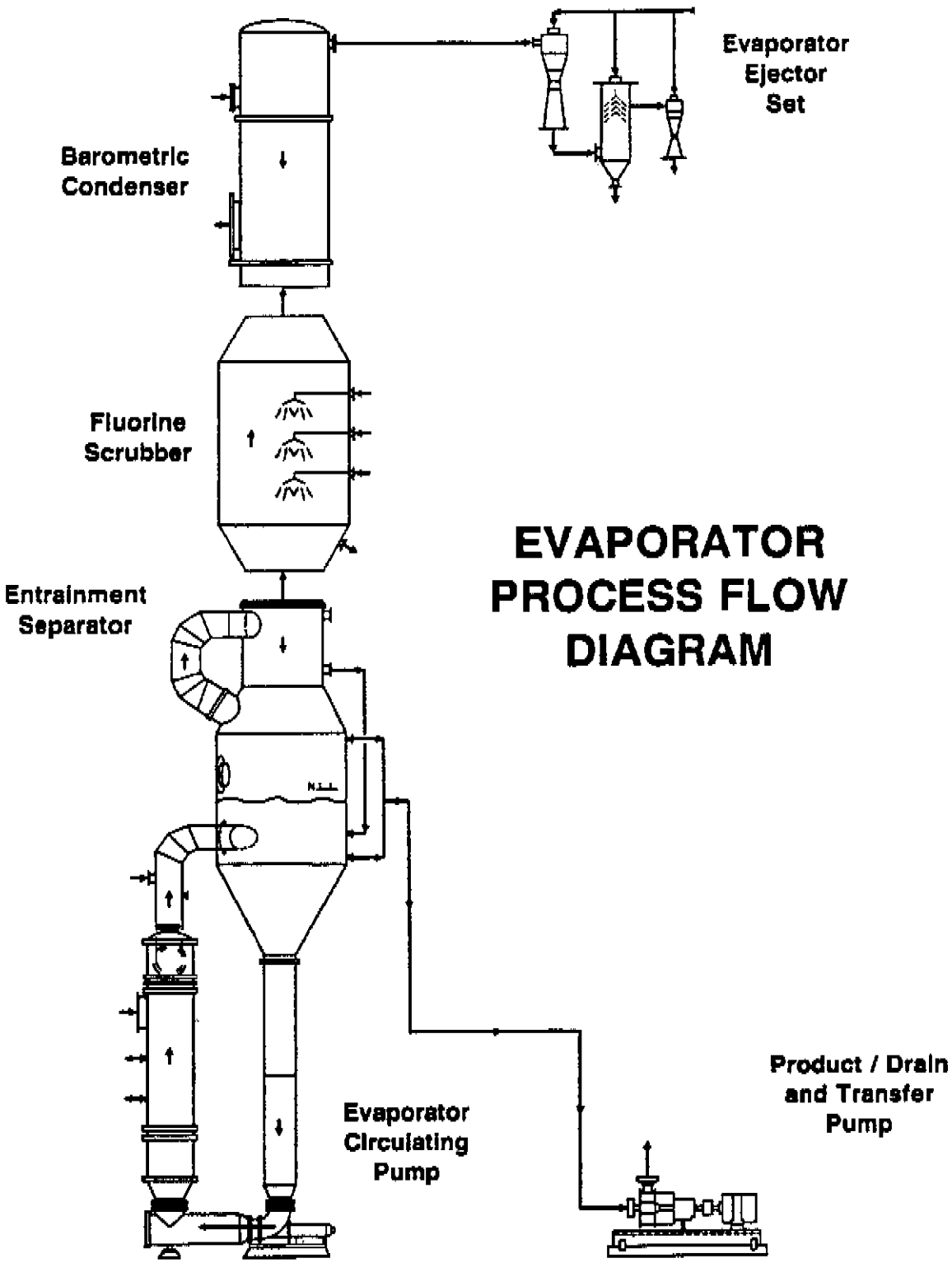

Evaporator
Ejector
Set
Barometric
Condenser
Fluorine
Scrubber
EVAPORATOR
PROCESS FLOW
DIAGRAM
Entrainment
Separator
Product / Drain
and Transfer
Pump
Evaporator
Circulating
Pump

FIGURE 3

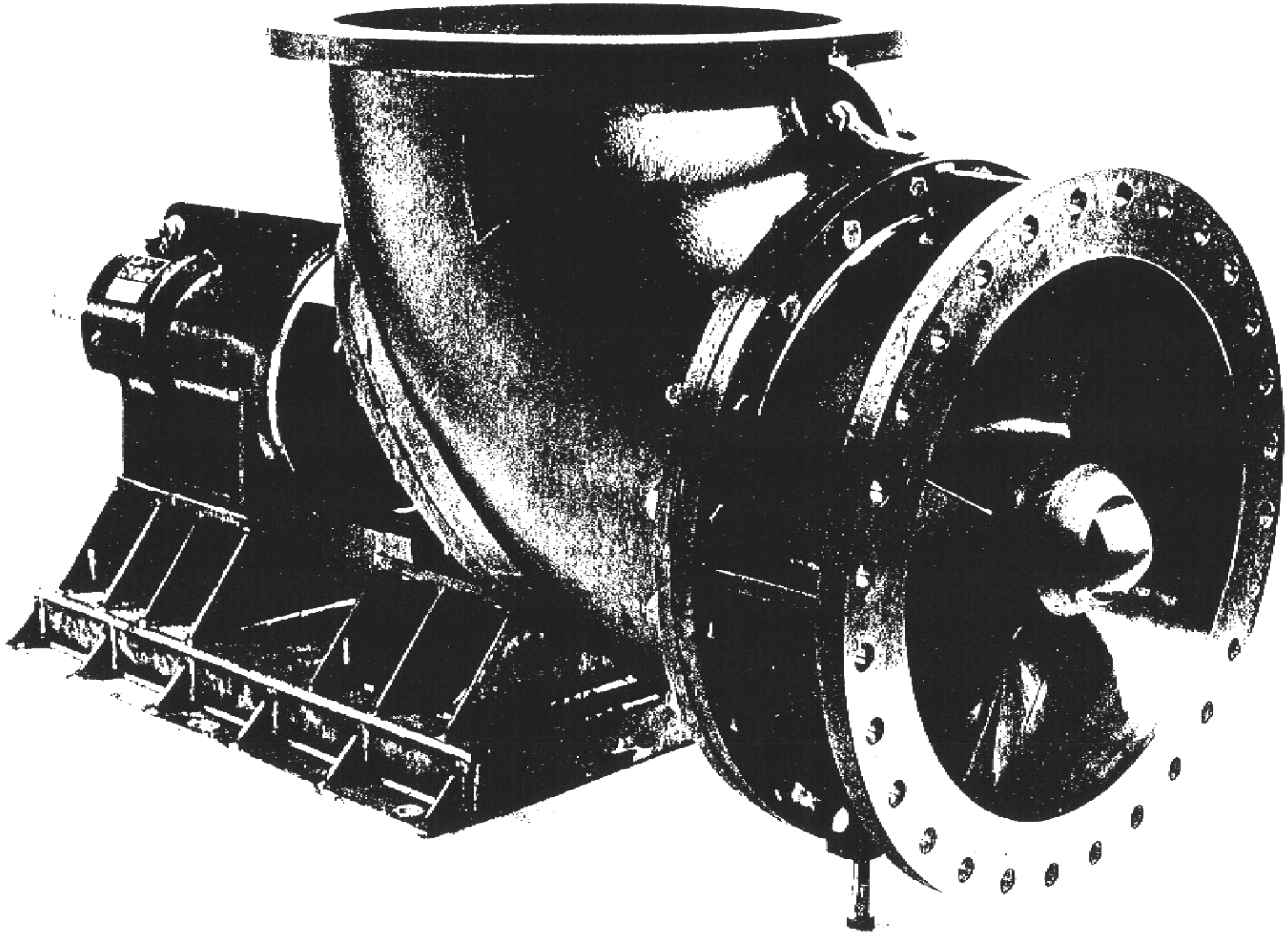


FIGURE 4 LEWIS 750MM AXIAL FLOW ELBOW PUMP

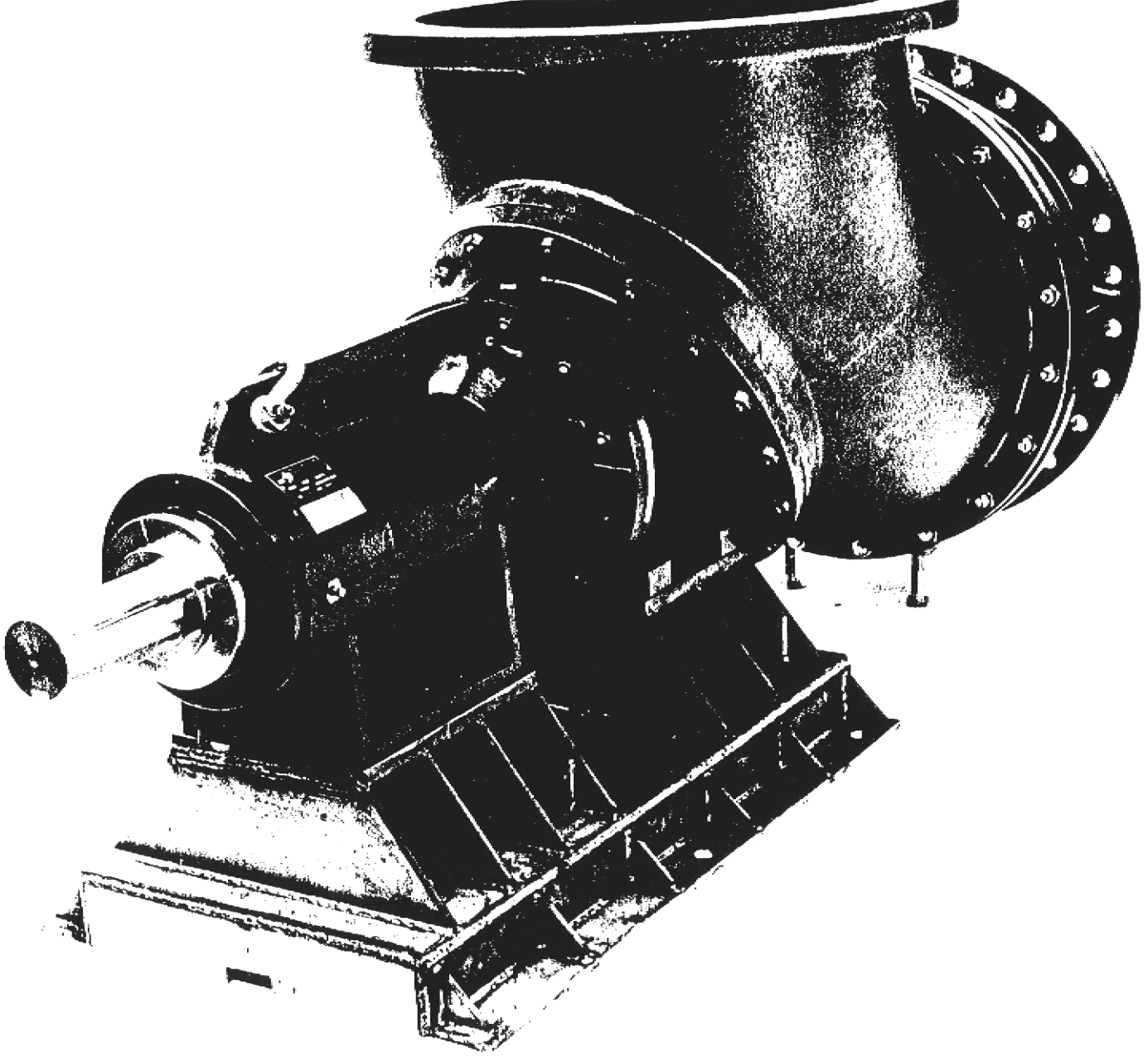


FIGURE 5 LEWIS 750MM AXIAL FLOW ELBOW PUMP