C. SUMMARY OF EQUIPMENT AND OPERATING PROBLEMS

SUMMARY OF EQUIPMENT AND OPERATING PROBLEMS

As is invariably the case in the early stages of the development of a new process, many operating and equipment problems were met at Montebello and most of them in connection with the synthesis reactor system have been solved satisfactorily. During the solution of these problems, much valuable knowledge and experience was gained. A discussion of these problems is included in the present report in the hope that this may result in the saving of both time and money at other laboratories where similar problems may be encountered.

1. Valves and Fittings

It was found that copper and brass were not suitable for practically any service in the generator or synthesis systems. Besides being not recommendable for high pressures and temperatures, these materials were attacked by the synthetic water-soluble and oil-soluble products, as well as by the fresh synthesis gas. Forged steel or cast steel valves and fittings were found to be the most practical. Semi-steel, cast iron, and malleable iron were considered unsafe because these materials tended to fracture under strain or sudden blows.

Most of the steel valves used at first at Montebello were manufactured by the Henry Vogt Machine Company. These valves were readily available in many styles and types, were easy to install because of the hexagonal-shaped ends, and were manufactured by an old, nationally-advertised company; but, by actual experience, it was found that almost every type of Vogt valve tried was unsatisfactory. They frequently would leak around the bonnets and past the seats in every type of service from cold water to high pressure steam. The possibility that this was caused by the type of service, as suggested by the Vogt representative, was eliminated when it was found that valves made by many other manufacturers were quite satisfactory.

At present the following valves are being used successfully: Edwards (globe); Crane, Chapman, and Worchester (gate); Nordstrom (cock); and Grove and Dragon (meter). The latter two are 1/4" barstock valves used on orifice runs and meter manifolds. Barstock valves have usually proved unsatisfactory, but these two appear to be made with more precision than is normally encountered.

Nordstrom plug valves (cocks) have been used on catalyst lines and although they have been the best of those tried, they are not completely adequate. Other kinds tried were Porter, Wedgeplug, Hamer, and Walworth; but there does not seem to be any small valve available which will give tight shut-off on high pressure lines containing powdered catalyst and hot (650-700°F.) gas.

2. Threaded Pipe Connections

In order to get leak-proof threaded pipe connections, it was necessary to cut perfect pipe threads. There was a tendency for the workmen to use whatever pipe-die lubricant was handy: motor oil, carbon tetrachloride, or even water. Pipe thread troubles were ended when the use of Sultex B cutting oil was made mandatory except for oxygen lines where the use of water was continued.

Pipe threads on oxygen lines were sealed with litharge and glycerine, whereas white lead was employed on other lines. White lead was not entirely satisfactory; it was expensive, prone to be wasted, poisonous, and unsuitable for hot lines. Several commercial compounds proved to be more adequate. "PIPETITE-Stik" compound made by Lake Chemical Company of Chicago, Illinois, fulfilled the requirements of a general purpose sealer, and was obtained in convenient pencil-length sticks for easy application. "Aviation Permatex" was also satisfactory. On hot lines which were to be disconnected later, the threads were coated with "Seal-rite No. 5" made by Macksons Company, New York, N. Y. This key-paste type of material permitted breaking connections easily even after extended exposure to high temperature. Since it was water-soluble in absence of heat, it was used only on steam and hot-gas lines.

3. Steam Traps

Yarway steam traps were tried on the 185 psig utility steam lines but were observed to be subject to fouling by small pieces of scale in the lines. This might have been eliminated by filters in the line, but Armstrong traps worked very well without the added expense of filters.

4. Packing

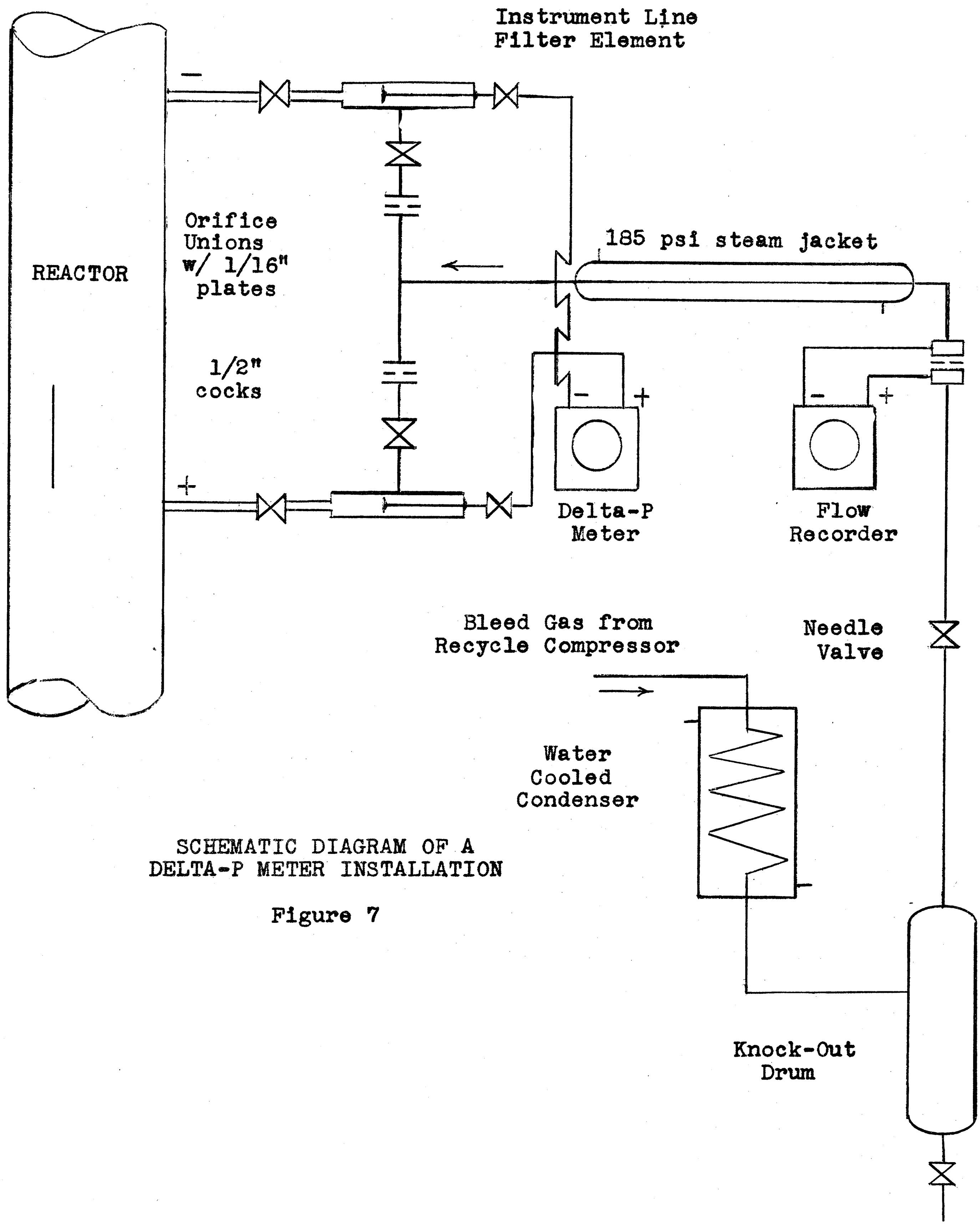
The piston-rod packing glands on the recycle compressor and on the generator quench-water pumps leaked frequently on high pressure or after several weeks of service. The rods were often scored by metallic packing such as Durametallic, and impregnated asbestos packing would not hold up under pressure and wear. Garlock Chevron packing alleviated this problem. At the present time all hand operated oxygen valves are packed with dry Johns-Manville pure braided asbestos. Motor actuated valves on oxygen service are lubricated with Nordstrom DC-234-S, a silicone base lubricant.

The meters were connected to the taps as indicated in the table below:

METER	RANGE	TAPS	DISTANCE BETWEEN TAPS
Cat Dens. or No. 1 dP	100" H_2O	1, 2	31.2"
Cat Dens. or No. 2 dP	100"	2, 3	31.2"
No. 3 dP	200"	3, 4	62.4"
No. 4 dP	50"	4, 5	62.4"
Steam Header or No. 5 dP	50"	5, 6	31.2"
Total dP	500"	1, 5	187.2"

The main difficulties experienced with the delta-P system were caused by plugging of the pressure taps and getting catalyst into the meters. The final scheme which proved satisfactory is shown in Figure 7, following. The filter elements were made from 1" stainless-steel immersion tubes (porosity E) manufactured by Micro Metallic Corp., Brooklyn, N. Y. Aloxite filters had been tried before, but they were not only too fragile but plugged too easily.

The orifice unions served two purposes: to take up the pressure drop from the bleed gas supply and to allow the even distribution of the bleed gas. One bleed gas supply was used for the three bottom taps, and one for the remaining taps. When everything was functioning properly, the flow of bleed gas could be varied several fold without affecting the delta-P readings. Each tap was purged with 300-500 SCFH of bleed gas. The gas bled through the lower two taps was considered part of the recycle and added thereto.



SCHEMATIC DIAGRAM OF A
DELTA-P METER INSTALLATION

Figure 7

The following formulas were used to compute catalyst data:

BED HEIGHT

$$\frac{\text{ht. (ft.)} \times 12}{\text{Total dP*}} = \frac{62.4}{\text{Cat. Dens.}}$$

(*in inches of water)

$$\text{total height (ft.)} = \frac{5.2 \times \text{total dP}}{\text{cat. dens.}} \text{ plus } 1^{(1)}$$

CATALYST DENSITY

density (#/cu. ft.) = 2 x dP No. 1

or = dP No. 1 plus dP No. 2

CATALYST INVENTORY

Inventory (pounds) = total bed ht. x 0.66 x cat.dens.(2)

---

(1) Added because the first pressure tap is 1 foot from reactor bottom.

(2) The area of open cross-section in the reactor was 0.66 sq. ft.