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RADIATION LABORATORY

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CAUSES OF FAILURE OF VACUUM SYSTEMS

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Berkeley, California

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CAUSES OF FAILURE OF VACUUM SYSTEMS

W. E. Bush

Vacuum systems, once built and put into operation, are usually accepted by the operating personnel as being essentially automatic. However, upon the slightest failure, such a system becomes a major obstacle to carrying on the process for which a whole plant is designed.

Actual systematic failures are generally easy to locate in case total failure of the system results, but operation which is near normal, but not quite satisfactory, often presents a major problem. The usual complaint in such borderline cases generally involves a certain definite set of symptoms, some combinations of which it might well be worth considering as typical.

The following key is designed to aid the uninitiated in locating the cause of failure in a poorly operating system. It is based upon the assumption that the system is operable and has previously been satisfactorily operated. Thus no design deficiencies are incorporated in such an attempted analysis. To use the key, the information first needed is that of rate of rise. The system will either have an acceptably high rate of rise (I) or a low rate of rise (II). If, for example, the former situation exists follow the key to item (3). Three possibilities should then be considered as listed. The system will be described by one of them. Follow the chart to the index number indicated by the appropriate statement of affairs. Do this progressively until the probable cause of the trouble is finally described.

It should be noted that in order to appraise a failing system it is necessary to incorporate equipment which facilitates quick and simple analysis. The slight increase in cost for valved outlets and thermometer wells in suitable locations will very soon be saved through the prevention of costly outage time.

Measurements found to be most desirable are the following:

a. Foreline pressure - Pirani gauge and McLeod gauge.

b. Rate of rise - trapped and untrapped ion gauges.

c. High vacuum pressure - trapped and untrapped gauges.

d. Pump base pressures - ion gauge (untrapped on pump).

e. Temperature of pump bottom plates - thermometer wells.

f. Circulation water input and output temperatures.

g. Pump speeds - by introduction of both calibrated and uncalibrated leaks.

h. Electrical power supplied to the heaters of the pumps.

While permanent installations of equipment necessary to measure all of these items are certainly not economical in any sense, every system constructed should be so designed as to allow easy use of portable equipment capable of enabling such measurements to be obtained by personnel in charge of trouble-shooting.

Key for Tracing Operating Troubles In A High Vacuum Pumping System

I High rate of rise - 3

II Low rate of rise - 7

3.(a) Rate of rise constant over considerable time (hours) - - - - - - - - - 4

or (b) Rate of rise varies from time to time - - - - - - - - - - - - - - 5

or (c) Rate of rise steadily decreasing - - - - - - - Probably Normal

4.(a) Fore-pressure shows no change when pump gate valves are closed.

This is probably due to a leak in the gate valve seals occurring only when the valves are closed.

or (b) Fore-pressure goes down when the gate valves are closed - - - 7

5.(a) Variable leak in moving seals.

or (b) Leak in an oil blocked gasket or ground surface.

or (c) Water leak sometimes frozen over - - - - - - - - - - - - - - - 6(b)

6.(a) Rate of rise same on trapped as untrapped gauge _____ air leak

or (b) Rate of rise considerably smaller on trapped gauge ____ water leak

7.(a) Pressure reading high - 8

or (b) Pressure fluctuating - 14

8.(a) Ion gauge rate of rise high - - - - leaky or gassy ion gauge assembly.

or (b) Ion gauge rate of rise normal - 9

9.(a) Pump speed normal - 10

or (b) Pump speed low - 17

10.(a) Base pressure of pumps high - 11

or (b) Base pressure of pumps low - 18

or (c) Small leak near ion gauge assembly (in valve or stem) - - -

11.(a) Fore-pressure above rated tolerance of boosters under load.

(b) Fore-pressure normal - 12

12.(a) Oil in diffusion pumps contaminated - - - - - - - - - - - - - - - - change oil

or (b) Heat on pumps too little or too great - - - - - - - - - - - - - - - 13

or (c) Cooling water flow on pumps inadequate - - - - Check top of pump

13.(a) Speed suddenly falls offat leak below rated capacity - - - Heat too low

or (b) Speed normal for large leaks - - - - - - - - - - - - Heat too high

14.(a) Foreline pressure too high - Reduce same

or (b) Foreline pressure normal - 15

15.(a) Heat on one or more diffusion pumps too low - - - - - - - - - - - - - Check

or (b) A pump with oil level incorrect - - - - - - - - - - - - - - - - - - 16

16.(a) Bottom temperature normal - - - - - - - - Oil level in booster too high

or (b) Bottom temperature higher than normal - - - - - - - Pump out of oil

17.(a) Heat incorrect - 13

or (b) Heat correct - 16

18.(a) Refrigerant thimble recently filled - - - - - - - - - - - - - - - - - - 19

or (b) Refrigerant thimble becoming empty - - - - - - - - - - - Fill it

19.(a) Very gassy material in tank -- wait or remove it.

or (b) Electrical leakage in ion gauge system - - - - - - - - - - - - - - -

Should be continuously checked

Other combinations are possible, but these described are by far the most common and are likely to be the first encountered by the inexperienced operator. An occasional circumstance will defy the most experienced vacuum specialist for explanation. Such apparatus usually suddenly begins to function without anyone knowing just what he did to correct its difficulty. Fortunately such cases are very rare.

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