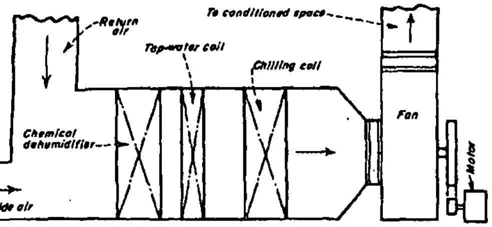
(11)




**WHEN THE RATIO** of latent to sensible heat is high the surface cooler can be supplemented by dehumidifying the air chemically before it enters the cooling coil

### Heat-Transfer Coefficient Vs Face Velocity

| Face Velocity, fpm | $h_s$ Btu/hr/sq ft/F |
|---|---|
| 350 | 5.9 |
| 400 | 6.8 |
| 450 | 6.9 |
| 500 | 7.2 |
| 550 | 7.8 |
| 600 | 8.0 |

the air and the surface according to equation 3 is:

$$(t_a - t_s)_m = \frac{85 - 64.5}{2.3 \log_{10} \frac{85 - 64}{64.5 - 64}} = 18.9 \text{ F}$$

The selected coil would have a surface area given by equation:

$$13. \quad A_s = \frac{H_s}{h_s (t_a - t_s)_m} \text{ or}$$

$$A_s = \frac{87{,}000}{7.2 \times 18.9} = 640 \text{ sq ft}$$

where 7.2 is the over-all coefficient of heat transfer taken from table above, which correlates $h_s$ and face velocity of air stream for the system under discussion.

The face velocity limits are those used *in practice* with the *maximum not* over 600 fpm. Best design would be 500 fpm, which we will use here. The over-all coefficients are for wet surfaces with moisture condensation that suits conditions. Required face area using a face velocity of 500 fpm is:

$$14. \quad A_f = \frac{Q}{v_f} = \frac{4000}{500} = 8.0 \text{ sq ft}$$

**Cooling-Surface Depth.** A coil having about 8 sq ft face area with a limiting face velocity of 600 fpm satisfies the job requirements. In addition, the coil's shape (number of rows deep) affects the dehumidifying efficiency of the system. As the depth of cooling surface increases more dehumidification is obtained with a greater slope of line 1 to 2 in Fig. 8. Various combinations are usually presented in manufacturer's data sheets in multiples of 2, 4, 6 and 8 row-deep coils.

Suppose that rating tables are not available, and a surface having the following characteristics is to be used:

| | |
|---|---|
| Ratio of outside surface to face area.... | 38.4 |
| Ratio of outside to inside surface....... | 9.6 |
| Heat transfer coefficient, refrigerant side, $h_r$ .............................. | 200 |
| Heat transfer coefficient, air side (table above) | |
| Face area (2-sq-ft multiples) | |

The coil, whose characteristics were computed in equations 13 and 14, has a ratio of outside surface to face area of 80, but the surface under consideration has a ratio of 38.4 per coil or 76.8 for two sections deep in the direction of air flow. Because this is less than the required 80 and the face areas come in multiples of 2 sq ft final economical selection is a coil two rows deep with a face area of 8 sq ft.

Fig. 6 (in Part I) may be checked mathematically if the refrigerant temperature is calculated directly. The inside area of the coil may be determined from information at hand:

$$A_r = \frac{8 \times 2 \times 38.4}{9.9} = 62 \text{ sq ft}$$

The refrigerant temperature is

$$t_r = 54 - \frac{(135{,}300)}{200 \times 62} = 42.1 \text{ F}$$

This agrees closely with the 45 F previously approximated.

Here we would choose a condensing unit having a capacity of 135,300 Btu per hr at an evaporator temperature of 43 F, or slightly lower to allow for pressure drop in the suction line.

## Telltales for Pressure Vessels

▶ MANY UNFIRED PRESSURE VESSELS are subject to corrosion or erosion, or both. Useful life can be extended by highly resistant materials or by thicker metal than needed to withstand working pressure safely.

In looking for evidence of *corrosion or erosion*, examine areas at (1) riveted joints (2) portions of metal that have been cold-worked and (3) heads designed with a short-knuckle radius where stresses may concentrate. Grooving points to active corrosion.

Corrosion on external surfaces can be seen if area is accessible. Only way to examine inaccessible surfaces is to expose them. If an area's condition looks dangerous, drill test holes to measure metal thickness.

As a precaution against failure, periodic inspection can be supplemented by drilling telltale holes in the metal wall. Most effective method is to drill holes into the plate from the surface opposite the one exposed to attack. Then corrosion or erosion opens the hole and allows the vessel's contents to leak out and *warn* the attendant. Never drill telltale holes too deep. Leave enough metal in the bottom to withstand working pressure safely. If there is any danger from leakage through the holes do not drill them.

If a leak develops in an unfired pressure vessel do not weld the hole, and put it back in service without thoroughly examining both surfaces. Someone may have drilled a telltale hole to warn of reduced thickness from corrosion or erosion. — *The Locomotive*



**TWO 5000-KW AUTOMATIC EXTRACTION** condensing units were converted to operate also as mixed-pressure units by replacing the check valve in the extraction line with a trip throttle valve. The turbine-inlet valves were drilled to pass 5000-lb-per-hr cooling steam through unit to the condenser when turbine is turning at rated speed but carrying no load

# Rebuilt Steam Turbines Modernize This Twenty-Year-Old Paper Plant

**To carry increased steam and electric loads at greatest over-all economy, two automatic-extraction condensing turbines were easily converted to act also as *mixed-pressure units*. Flexibility and efficiency over wide load range feature new setup, which includes a large new noncondensing turbine-generator**

By G H SUHS, *Chief Engineer, Sorg Paper Co*
and R D McARTHUR, *Turbine Specialist, General Electric Co*

▶ IN 1928, THE SORG PAPER Co, Middletown, Ohio, installed two 5000-kw condensing automatic-extraction turbine-generators with three boilers to supply power and steam to its mill. At that time steam at 20 psig was used for drying paper. This product was largely a soft white paper, needing relatively little power.

The turbines were built for operation with 400-psig 700-F inlet steam, 2-in. Hg abs exhaust, automatic extraction at 20 psig and uncontrolled-extraction of small steam quantities at about 80 psig. Original plant layout is shown on p 72, and the individual turbine performance curves on p 73. Original peak electric load with all six paper machines running was 3750 kw. One turbine could carry the load with the other unit acting as emergency standby.

In its day this plant, one of the most progressive industrial power units built, had fully justified its design.

**Growing Loads.** Steam and electrical loads grew with passing time because of higher production and changes in paper type. Production increased from 30,000 tons annually in 1928 to 70,000 tons in 1946. Also, the paper machines were speeded up, needing more power and higher-pressure steam in the driers. At present, six paper machines use 9000 kw and the largest machine alone takes 3000 kw. Energy requirements often exceed 215,000 kwhr daily.

Additional boiler and turbine capacity were needed, so a study was made of alternate schemes. Steam at 600 psig was considered, but the gain was not enough to justify two plant pressures with increased design and operating complications. This probably would not be true if the original pressure had been 250 psig or less. A new boiler was installed in 1946 to produce