Meal Drying and Cooling

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The drying and cooling of meal following the extraction of the oil, especially from the solvent process, is an important part of the overall process. The meal from the desolventizer unit is fed into the dryer at 18 to 20% moisture and 220 F. The meal is usually dried to 12% moisture. Rotary steam tube dryers are used for this drying operation and are normally operated countercurrently, with the meal and the vapors traveling in opposite directions through the dryer. Saturated steam at ca. 100 psig is used as the heat source.

Sufficient ambient air must be provided through the dryer to carry the vapors to the atmosphere and can be fairly accurately controlled with an adjustable damper in the vapor stack. An exhaust fan at the vapor discharge end of the dryer will provide the uniform volume of air required.

The exhaust temperature of the vapors leaving the dryer should be 180 F dry bulb, 70% relative humidity and 172 F wet bulb. This air formula will provide a moisture pick-up of 3150 grains per pound of air required.

The pounds of moisture to be evaporated per minute x 7000 ÷ by the 3150 grain pick-up will indicate the pounds of air per minute required to handle the drying assignment.

Under these conditions the meal should leave the dryer at approximately 180 F. There is a direct relationship between the moisture content of the discharged meal and its temperature. It is quite necessary that the meal be cooled after leaving the dryer before packaging or storage. The temperature should be reduced to a maximum of 100 F.

Either of two types of rotary coolers are available for this purpose; namely, air and water tube. Rotary air coolers can be used, either parallel or counter-flow, depending upon atmospheric conditions or preference of purchaser. Some evaporating cooling is accomplished in air cooling of the meal in an amount of 1 to 1½%. Water tube coolers use water circulating through the tubes to pick up the heat from the meal. Little, if any, air is required to circulate through the cooler. This type cooler has a slight advantage over the air cooler as ambient temperatures are not a factor in the cooling.

TYPICAL CALCULATIONS FOR DETERMINING SQUARE FEET OF HEATING SURFACE, AIR AND STEAM REQUIREMENTS FOR A GIVEN DRYING CAPACITY

This calculation is based on 144,000 lb at 19% H_2O being dried down to 12% H_2O.

Matl. ent. dryer	144,000#/hr at 19% H_2O
Mat. leaving dryer	132,545#/hr at 12% H_2O
	11,455#/hr evaporation
	191#/min evaporation

Operating steam pressure 100 psig.
Heat Transfer 12 BTU/sq ft/°TD.

Evaporation $\frac{11,455 \times 971}{12 \times 142}$ = 6527 sq ft tube surface

Heat req'd. to heat H_2O in material from 200 F to 212 F.

11,455 x 12 = 137,460 BTU/hr.

No additional heat req'd. to heat matl. as it enters dryer at ca. 200 F.

Air req'd. for absorbing vapors from contact drying on basis of air leaving dryer at 180 FDB - 70% R.H. - 172 FWB.

This air would contain 3277 grains per # DA volume 28 cu ft/# would indicate a pick-up of 3167 grains of H_2O.

$\frac{191 \times 7000}{3277 - 110}$ = 423#/air/min.

423# x 28 = 11,844 CFM at 180 F at fan.

423 x 13.34 = 5643 CFM at 70 F entering air.

Air to be heated from 70 F to 180 F.

423 x .24 x 110 x 60	= 670,032 BTU/hr
Radiation loss	= 227,460 BTU/hr
Total	897,492 BTU/hr

$\frac{897,492}{12 \times 142}$ = 527 sq ft additional H.S. req'd.

Total heat surface req'd. 6527 + 527 = 7054 sq ft.
10 ft-0 in. x 50 ft-0 in. rotary steam tube dryer has 7182 sq ft H.S.

11,455 ÷ 7054 = 1.6# evaporation/sq ft H.S./hr
Steam requirements would be ca. 12500# or 1.1# evaporation per pound of steam.

TYPICAL CALCULATIONS FOR DETERMINING AIR REQUIREMENTS FOR COOLING SOYBEAN MEAL USING AMBIENT AIR AS THE COOLING MEDIUM TO BE COOLED FROM 210 F to 110 F. CALCULATIONS BASED ON COOLING 66.27 TONS/HR OR 132,545# /HR AT 12% MOISTURE

Air entering cooler 90 FDB - 76 FWB - 38.7 BUT/# DA - 113 GR/# DA.
Air leaving cooler 130 FDB - 105 FWB - 310 Gr./# DA.
77.5 BTU/# DA VOL. 15.8 cu. ft./# DA.

Heat pick-up 77.5 - 38-7 = 38.8 BTU/# DA

HEAT GIVEN UP BY MATERIAL.

(116,640 x .4) + (15,905 x 1) x 100 = 6,256,100 BTU/hr

$\frac{6,256,100}{38.8 \times 60} = \frac{6,256,100}{2328}$ = 2687# air/min.

2687 x 13.34 = 35,844 CFM at 70 F.
2687 x 15.8 = 42,455 CFM at 130 DB - 105 WB

EVAPORATION DUE TO COOLING

2687 x 310 = 832,470 GR.
2687 x 113 = 303,631 GR.
528,839 GR.

528,839 = 75.54# water evaporation/min.

11 ft - 0 in. Diam. x 55 ft - 0 in. Rotary cooler

Maintain 450 FPM at 130 F air max.

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