UN CONCEPTO INTEGRAL EN EL TRATAMIENTO DE AGUAS INDUSTRIALES

Aguas de Proceso

BOLETÍN TÉCNICO

QUICK CALCULATION OF COOLING TOWER BLOWDOWN AND MAKEUP

Cooling tower blowdown is important to the utility balances for new plants, to the control of scaling in cooling equipment and to the operation of cooling towers. Moreover, the approach used for its calculation can be applied for a variety of process operations where a pure component is removed (by reaction, physical separation, etc.) from recycling stream and replaced by a feed stream that contains impurities. In each case a blowdown or bleedoff is used to take out the impurities, which are allowed to become concentrated in the recycle stream. When the system is at equilibrium, the makeup must equal the losses, and for cooling towers: **M = E+B+W**

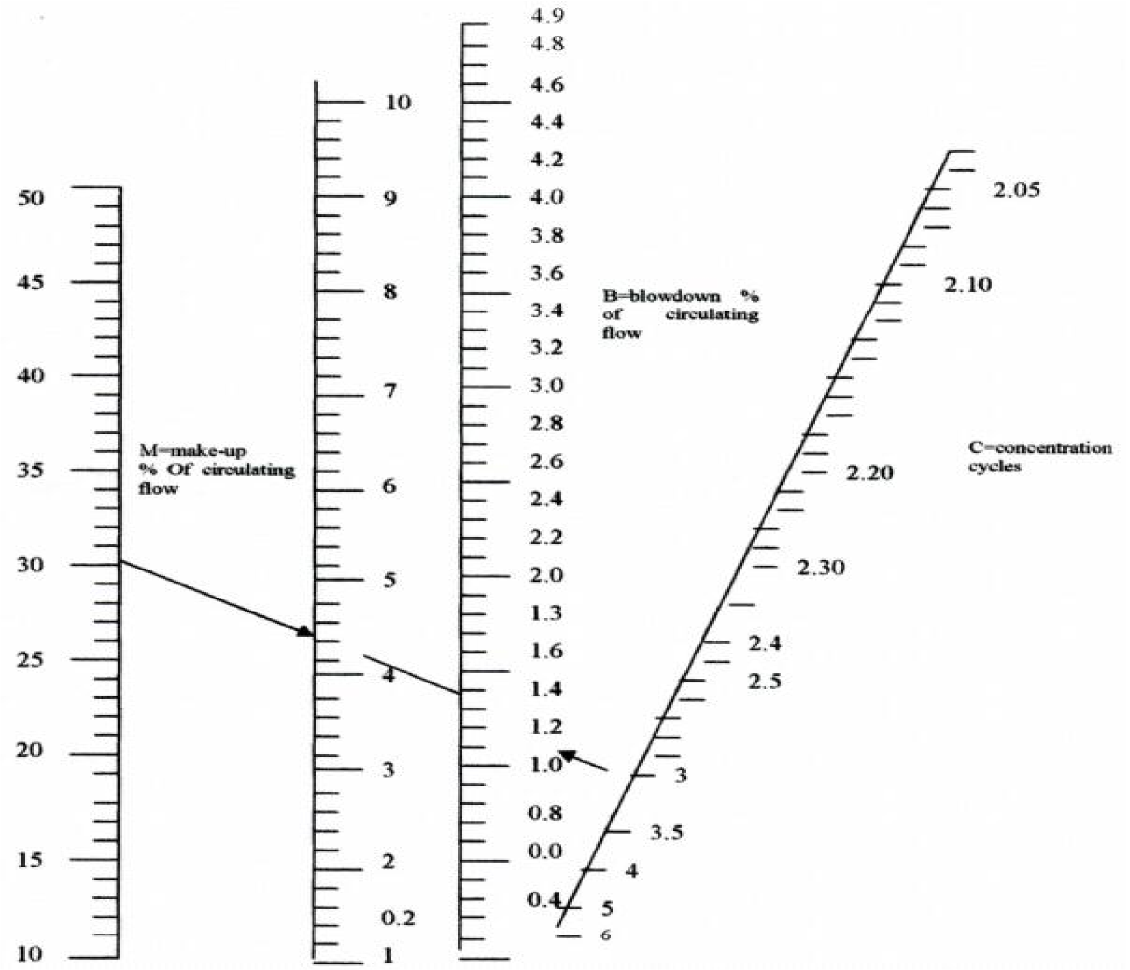
Where:

M= makeup % of circulation

B= blowdown % of circulation

E= evaporation loss, % of circulation

W= windage loss and leakage loss, of circulation



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Since the evaporation water will be essentially free of dissolved solids, all those introduces with the makeup water most be removes by the blowdown plus windage loss, or:

$$Mpm = (B+W)Pc$$

Were
Pm = concentration in the makeup, ppm.
Pc = concentration in circulating water, ppm.

For cooling tower, the concentration in the recirculating water is arbitrarily defined as cycles of concentration, C, as:

$$C = \frac{\text{concentration of cooling water}}{\text{concentration in makeup water}}$$

so that:

$$M = (B+W)Po/Pm = (B+W)C$$

Now, experience has shown that windage losses range: 1.0-5.0 % for spray ponds, 0.3-1.05 for atmospheric cooling tower, and 0.1-0.3 % for forced draft cooling towers, and that 0.1 % can be assumed for modern formed-draft tower. Also, a heat balance plus experience shows that evaporation losses are 0.85-1.25 % of the circulation for each 10˚ F drop in the temperature across the tower, and then an evaporation loss of 1.0 % for each 10˚ F drop can be assumed for most calculation, so that:
$E = \Delta T/10$

Thus:

$$M = \Delta T/10 + B + 0.1$$

Combining Eq. (3) are (4):

$$\Delta T/10 + B + 0.1 = (B + 0.1)C$$
$$\Delta T/10 – 0.1(C-1) = B(C-1)$$

$$B= \frac{\Delta T}{10\ (C-1)}$$

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The monograph permits a rapid, simultaneous solution of Eq. (1) and (5). Example: a cooling tower handles 1, 000 gpm of circulating water, which is cooled from 110° F to 80° F. What blow down and makeup are required if the concentration of dissolved solids is allowed to reach 3 times that in the makeup? On the monograph, align C = 3.0 with ΔT = 30 and read B = 1.4% or 14 gpm, and M = 4.5% or 45 gpm.

By analogy, this type of monogram can be adapted to calculating the bleed from the synthesis loop of an ammonia plant. In that case, M would be makeup synthesis gas as % of recycle gas, E + W the conversion per pass, B the bleed recycle gas, Pm and Pc the concentration of methane in the recycle and makeup gases, respectively, and C the ratio of methane un the recycle gas to that in the makeup gas.

When the above assumptions for evaporation and wind age losses are transposed to conversion per pass, and when the ranges of the different lines extended, the monogram can be adapted.

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