Annex C
(informative)

Sample calculations for sizing a subsonic flare stack

C.1 General

This annex presents examples of the two methods used to size subsonic flare stacks based on the effects of radiation. The first method covered is the simple approach presented in Clause 6; the second is the more specific approach using Brzustowski's and Sommer's method [94]. The height and location of the flare stack should be considered, based on gas dispersion if the flame is extinguished (see 6.3).

C.2 Example 1 — Sizing a flare stack using the simple approach

C.2.1 Basic data

In this example, the material flowing is hydrocarbon vapours. The mass flow rate, q_m, is 45 360 kg/h (100 000 lb/h). The average relative molecular mass of the vapours, M, is 46,1. The flowing temperature, T, is 422 K (760 °R). The compressibility factor, Z, is 1,0. The heat of combustion is 50 000 kJ/kg (21 500 Btu/lb). The absolute pressure within the flare tip while flaring, p_2, is 101,3 kPa (14,7 psi). The design wind velocity (u_∞) is 32,2 km/h (8,9 m/s) [20 mph (29,3 ft/s)].

C.2.2 Calculation of flare diameter

The Mach number is determined from Equation (27) or (28) from 7.3.1.3.3:

In SI units:

$$Ma_2 = 3{,}23 \times 10^{-5} \left(\frac{q_m}{p_2 \cdot d^2} \right) \left(\frac{Z \cdot T}{M} \right)^{0{,}5} \tag{27}$$

In USC units:

$$Ma_2 = 1{,}702 \times 10^{-5} \left(\frac{q_m}{p_2 \cdot d^2} \right) \left(\frac{Z \cdot T}{M} \right)^{0{,}5} \tag{28}$$

For $Ma_2 = 0{,}2$, the flare diameter is calculated as follows:

In SI units:

$$0{,}2 = 3{,}23 \times 10^{-5} \left(\frac{45\,360}{101{,}3 d^2} \right) \sqrt{\frac{1 \times 422}{46{,}1}}$$

$$d^2 = 0{,}219$$

$d = 0{,}468$ m (inside diameter)