APPENDIX 703: Fluid dynamics, Flow of gases and steam through nozzles, Derivation of equation for calculating length of conical Laval nozzle

The derivation is carried out on the basis of FIGURE 703, (p. 10) by a methodical procedure.

For the length of the divergent part of the nozzle:

$$l = t + (x_e - x_t).$$

The difference between the end of the nozzle (index e) and the end of the rounded part of the nozzle (index t) can be derived from the nozzle angle α:

$$\tan\frac{\alpha}{2} = \frac{r_e - r_t}{x_e - x_t} \Rightarrow x_e - x_t = \frac{r_e - r_t}{\tan\frac{\alpha}{2}}.$$

Combining the last two formulas we obtain:

$$l = t + \frac{r_e - r_t}{\tan\frac{\alpha}{2}}.$$