

Question 16 **June 2004 No. 1.2**

A boiler with a heat transfer efficiency of 30 % generates 15 ton/h of dry saturated steam from and at 100 °C. Coal of calorific value 25 MJ/kg is laid 100 mm deep on a 1,2 m wide x 2 m long chain grate. If the ash is to contain 2 % unburnt coal, determine the required speed of the chain grate.

Assume the density of coal is 1 350 kg/m³.

(7,898 mm/s)

Author's note:

The note in italics shows information that was not supplied in the exam. The examiners often omit data and then point to instruction 4: "Candidates are expected to make reasonable assumptions where necessary and these, together with any formulae used, must be clearly stated."

As such, this study aid supplies these bits of data at the end of each question, indicated by the term "Assume".

Solutions are handwritten. These answers have been checked repeatedly.

Attempting to type it out at this stage will lead to unnecessary typing errors, with associated frustration for students.

Q 16

$$\eta_{\text{Boiler}} = 30\%$$
$$\dot{m}_s = 15 \text{ ton/h @ } 100^\circ\text{C}$$
$$CV = 25 \text{ MJ/kg}$$

* Ash 2% unburnt coal

$$\eta_B = \frac{\dot{m}_s \Delta h}{\dot{m}_f CV}$$
$$0,3 = \frac{15 \cdot 2256,9}{\dot{m}_f \cdot 25000}$$
$$\dot{m}_f = \underline{\underline{4513,8 \text{ ton/h}}} = \underline{\underline{1,2538 \text{ kg/s}}}$$

Allowing for 2% un-burnt coal in ash:

$$\dot{m}_f = \frac{1,25}{0,98} = \underline{\underline{1,2794 \text{ kg/s}}}$$
$$\dot{m} = \rho \cdot A \cdot V$$
$$1,279 = 1350 \cdot (0,1 \cdot 1,2) \cdot V$$
$$V = \underline{\underline{7,898 \text{ mm/s}}}$$