Trainer Instructions: Furnaces and Refractories

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Title	**FURNACES AND REFRACTORIES**
Objective	To obtain an understanding of furnaces and refractories, including the types of furnaces and refractories, how to assess their performance and the main areas for energy conservation.
Minimum duration and approach	▪ 2 sessions (3 hrs), including the quiz and workshop exercise ▪ Recommended approach: spend 1 session (1.5 hrs) on the PowerPoint presentation. Explain the quiz and workshop exercise before the break and resume after 1 hour into the second session to go through the answers. ▪ Presentation: 56 slides ▪ Textbook chapter: 36 pages
Contents	▪ Introduction ▪ Types of furnaces, refractories and insulation ▪ Assessment of furnaces and refractories ▪ Energy efficiency opportunities
Assessment of participants	▪ Pose questions during the presentation. Some suggested questions are included in the trainer notes underneath each slide. ▪ Take the quiz with 10 multiple choice questions. ▪ Carry out the workshop exercise. Participants can be asked the following: *A steel billet preheating furnace operates between 7 am to 8 pm. The output of the furnace is 14 TPH and the last batch of the stock is removed from the furnace at 8 pm. In the first hour, 0.25 kL of furnace oil is fed to the furnace to raise the furnace temperature. It is assumed that the same amount of heat is also lost during the cooling of the furnace after 8 pm.* *Operating parameters after furnace stabilization following the first hour are given below.* - *Average surface temperature of heating and soaking zone (area = 78 m2): 120 0C* - *Average surface temperature of areas other then heating And soaking zone (area = 12 m2): 85 0C* - *Furnace wall thickness on the billet extraction outlet side: 460 mm* - *Opening on the billet extraction side: 1 m x 1m* - *The outlet is opened: 12 times/d for 15 min* - *Emissivity of furnace wall: 0.8* - *Operating temperature of the soaking zone: 1340 0C*

	- *Average flue gas temperature after air preheater: 750 0C* - *Specific heat Cp of flue gas: 0.24 kCal/kg per oC* - *Average O2 %: 10%* - *Ambient temperature: 30 0C* - *Theoretical air requirement of furnace oil: 14 kg air / kg fuel oil* - *GCV of fuel oil: 10000 kCal/kg* - *Average fuel oil consumption: 600 l/hr* - *Specific gravity of furnace oil: 0.92* - *H2 in furnace oil: 12%* - *Moisture in furnace oil: 0.25%* - *Radiation factor for D/X ratio of 2.17 (from graphs): 0.71* - *Black body radiation at 1340 0C (from graphs): 36 kCal/kg/m2/hr* - *Heat loss at 1200C through roofs and side walls: 1250 kCal/m2/hr* - *Heat loss at 85 0C through other areas: 777 kCal/m2/hr* *Calculate the operational efficiency of the furnace. The heat loss in the initial hour can be neglected.* Participants should make use of the formulae and example provided in the textbook chapter (Section 3.3). It is important to note that the example in the textbook calculates the percentage losses, and in the workshop exercise the actual heat loss in kCal is calculated for each source of heat loss!
Other comments	▪ There many slides and it takes time to go through each one so the session will require the full 1.5 hours available. If the quiz and workshop exercise are also completed, 2 full sessions are needed. ▪ If time is limited an alternative is to talk through the example calculation of combustion efficiency in the textbook chapter (Section 3.3) instead of doing the workshop exercise. ▪ Case study options from www.energyefficiencyasia.org or other sources could be included in this session as an illustration of how other companies reduce energy consumption and costs.