Passive Fireproofing for Downstream Installation – *Material Selection and Extent of Fireproofing*

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A hydrocarbon fire inflicts initial damage by directly heating beyond the limits of and destroying facilities, equipment and buildings. It becomes detrimental when more damage occurs when the fire spreads due to the collapse or rupture of vessels caused by metal or steel failing under initial fire exposure. The fireproofing of structural steel exposed to hydrocarbon fires has been used for many years with varying degrees of success from conventional concrete and lightweight concrete. Underwriters laboratories developed the UL-1709 test procedure based on hydrocarbon fire exposure where the temperature of the fire exposure rises to 1093℃ (2000℉) within the first 5 minutes compared to commercial fire based on ASTM E-119 which takes four hours to develop the same temperature (see figure below).

FIRE SCENARIO ENVELOPE

The fire scenario envelope is the key and primary basis in establishing the fire resistance rating of fireproofing materials used as well as determining the appropriate dimensions to use for planning fire protection. As a rule of thumb for hydrocarbon fuels, a frequently used frame of reference for the fire-scenario envelope is one that extends 6m to 12m horizontally, and 6m to 12m vertically, from the source of the liquid pool.

EXTENT OF FIREPROOFING

In general, structures and supports which needs a fireproofing area are as follows:

- Fireproof supports for all horizontal, vertical and spherical storage tanks
- Fireproof supports for all fired heaters elevated above grade
- Fireproof tower skirts, anchoring rings and bolts on the outside
- Fireproof supports for vessels, such as receivers, accumulators, reboilers, reactors, heat exchangers and other vessels with liquid holdup capacity to the full bearing height. This includes vessels installed in elevated structures, above pipe racks or attached to towers or other vessels
- Fireproof all major load bearing structures or buildings which support vessels such as receivers, accumulators, reboilers, reactors and heat exchangers to the full load-bearing height when exposed to flammable or combustible material spills:
  - Fireproof both the vertical and horizontal members of the first level of a pipe-rack located within 8m of heaters, pumps, towers and major vessels handling flammable or combustible materials.
  - Do not locate pumps and compressors handling flammable or combustible materials under equipment or pipe rack. Fireproof pipe rack levels above pumps and compressors handling these materials.
  - If air-cooled heat exchangers are installed above pipe racks, fireproof pipe rack levels above the first level and the legs of heat exchangers to the full load-bearing height.
  - Do not install vessels with large liquid hold-up above pipe racks. If such vessels must be installed above pipe racks, fireproof them to the full load-bearing height of the vessel supports and all levels of the pipe rack supports.
- Fireproof the legs of air-cooled exchangers in flammable liquid service that are installed at grade level. Protection is not needed for air-cooled heat exchangers in anything other than flammable liquid service, installed at grade level and located 15m from the process equipment and from a gas or spill hazard.
- Fireproof supports for compressors, turbines and turbo expanders to the full load-bearing height.
- Fireproof exposed, important grouped power, control and instrumentation cables; tubing or conduit; and fire sensitive thermal insulation on critical equipment. The fireproofing for this

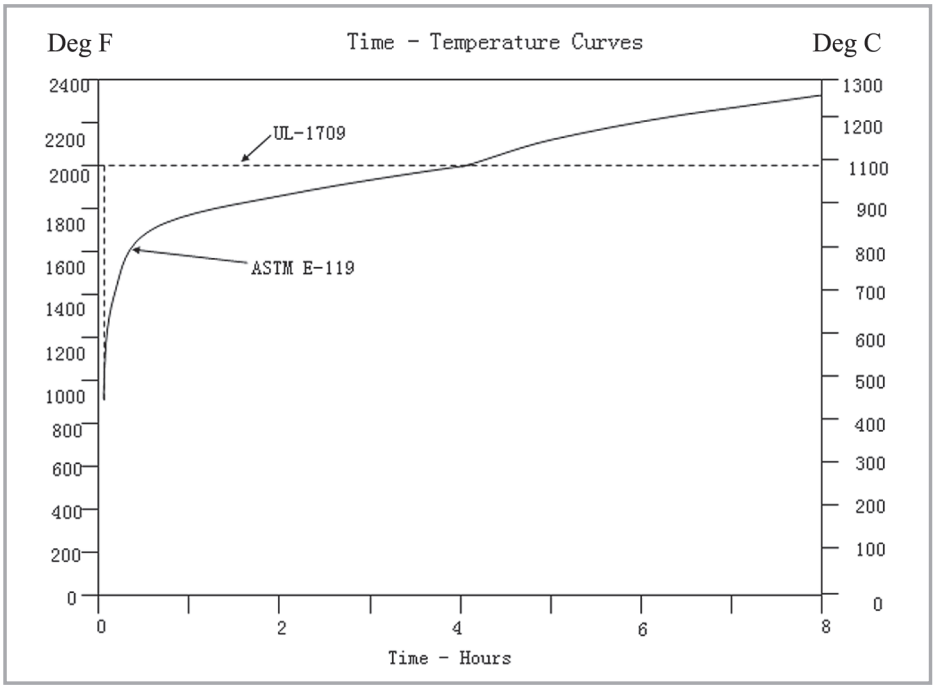

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Table 1: Cost comparison of fireproofing material using concrete and lightweight concrete

Type of Fireproofing	Fire Rating	Thickness	Application Type	Supply and Install, Budgetary
Normal Concrete, Equipment Skirt (steel)	2 hours	50 mm	Cased formed concrete	US$18/m^2
Steel Pipe-rack using gunite concrete	2 hours	50 mm	Spray	US$25/m^2
Steel pipe rack using light weight concrete, for example, FENDOLITE TG by Cafco	2 hours	34 mm	Trowel	US$130/m^2

application normally only needs 30 minutes of protection rating to allow sufficient time for the shutdown of the process unit.

- Evaluate the processes and equipment, and arrange the valves and controls to fall in a safe position.

MATERIAL SELECTION-ADVANTAGES AND DISADVANTAGES

Concrete structures are most commonly used as passive fireproofing material due to cheaper cost (refer to Table 1) compared to the proprietary lightweight cementitious/vermiculite concrete (like Cafco 800, Fendolite TG or Pyrocrete 240). The advantages and disadvantages for both are listed for comparison.

(A) Dense Concrete
(specific weight = 2300kg/m^3)

- Major advantages
  - Durability; can withstand thermal shock and direct hose streams, can withstand direct flame impingement up to 1110°C
  - Ability for most contractors to satisfactorily apply, extensive proven performance; can provide four or more hours of protection
  - Cheaper in cost
- Major disadvantages
  - Relatively heavy in weight, need reinforcement, installation cost and time, possible spalling effect due to hydrocarbon fire

(B) Light Weight Cementitious Vermicullite Concrete (specific weight = 700kg/m^3)

- Major advantages
  - Have better fire-protection properties compared to dense concrete (for equivalent coating thickness) and much better in weight basis, capable of withstanding flame impingement up to 1100°C, can withstand thermal shock and high-pressure hose streams
- Major disadvantages
  - Porosity, additional cost to introduce sealer top coat and shielding protection requirement
  - More susceptible to mechanical damage, more expensive, need licensed applicator

CONCLUSION

Conventional concrete material as a means of fireproofing in Asia Pacific projects is widely used due to its cheaper cost as noted before. New study and research as noted in the NIST Special Publication and report by HSE, Ove Arup & Partners in the UK indicates that '**high strength concrete**' when exposed to a hydrocarbon fire is vulnerable to the loss of compressive strength and spalling effect. However, in North America and Europe, since the base material of the structures are predominantly steel, lightweight concrete as means of fireproofing is the preferred choice.

It is, therefore, important during the proposal stage, and depending upon the geographical location of the plant being built, a careful estimated pricing with regards to the type of fireproofing selection is being considered since there is a big variation in price for the different types of materials chosen. ■

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