REMAINING LIFE CALCULATION OF HEATER TUBES

AS PER API 530

DESIGN & OPERATING DATA

- Tube Material - 25Cr-20Ni (HK40)
- Nominal OD - 208.0 mm
- Maximum measured OD - 209.5 mm
- Minimum sound wall thickness (MSW) - 18 mm
- Measured minimum thickness - 18.5 mm
- Design pressure - 3.5 MPa
- Design temperature - 850 °C
- Operating pressure - 3.237 MPa
- Operating temperature - 800 °C
- Limiting Design Metal Temperature – 954 °C
- Larson-Miller Constants - 10.4899
- Service life - 54000 hours
- Design Life – 100000 hours

EQUATION FOR STRESS

- This procedures is for thin tubes (tubes with a thickness-to-outside diameter ratio T_{min}/Do of less than 0.15)
- The mean-diameter equation for stress is as given below
- $\sigma = P/2\ [(D_O/T_m) - 1]$

Where

- σ is the stress, expressed in megapascals
- P is the operating pressure, expressed in megapascals
- Do is the measured outside diameter, expressed in millimeters
- T_m is the measured thickness, expressed in millimeters
- $\sigma = 3.237\ /2\ [(209.5/18.5) - 1]$
- $\sigma = 16.74$ MPa

LARSON-MILLER PARAMETER

- **Larson-Miller Parameter Curves** shows Larson-Miller Parameter as a function of stress. The Larson-Miller Parameter as a function of stress [LMP (σ)] is calculated from the design metal temperature, T_D and the rupture Life T_{RL}.

When T_D is expressed in degrees Celsius:

- LMP (σ) = (T_D + 273) (C_{LM} + log10 T_{RL})
- When T_D is expressed in degrees Fahrenheit:
- LMP (σ) = (T_D + 460) (C_{LM} + log10 T_{RL})
- The Larson-Miller constant have been optimized, specific for each individual material group. The Larson-Miller Constants for minimum and average properties for each alloy. These values were obtained from Table 3 and Table 3M of WRC 541.
- The plot of the minimum rupture strength against the Larson-Miller Parameter is included so that the rupture allowable stress can be determined for any design life. The curves shall not be used to determine rupture allowable stresses for temperatures higher than the limiting design metal temperatures.

LMP/1000 = 17.15

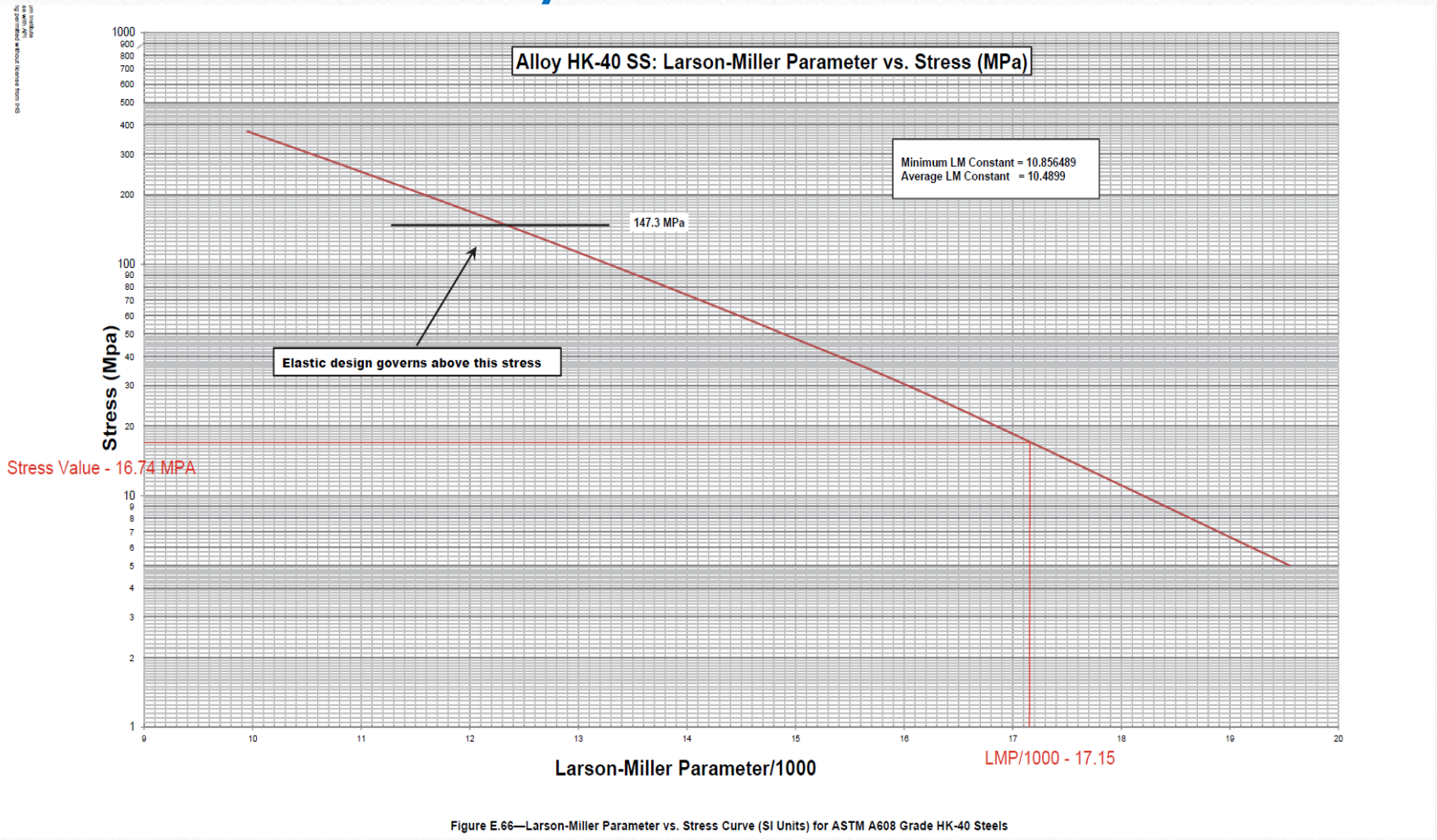

Figure E.66—Larson-Miller Parameter vs. Stress Curve (SI Units) for ASTM A608 Grade HK-40 Steels

Remaining life – T_{DL} @800°C

- LMP (σ) = (T_D + 273) (C_{LM} + log10 T_{RL})
- 17.15 *1000 = (800+273) (10.4899 + $\log_{10} T_{RL}$)
- $\text{Log}_{10} T_{DL}$ = 5.5
- T_{RL} = 316,225 hours
- T_{RL} = 36.1 years

- Life fraction calculation (L_f) = Running life (T_{RunL}) / Rupture life (T_{RL})
- Life fraction calculation (L_f) = 54000 / 316225 = 0.1707
- Remaining Fraction = 1-0.1707 = 0.8293
- Remaining hours = Remaining fraction * Design Life Hours
- Remaining hours = 0.8293 *100000 = 82930 hours

Remaining life – T_{DL} @850°C

- LMP (σ) = (T_D + 273) (C_{LM} + log10 T_{RL})
- 17.15 *1000 = (850+273) (10.4899 + $\log_{10}$ T_{RL})
- $\text{Log}_{10}\, T_{DL}$ = 4.8226
- T_{RL} = 66466 hours
- T_{RL} = 7.56 years

- Life fraction calculation (L_f) = Running life (T_{RunL}) / Rupture life (T_{RL})
- Life fraction calculation (L_f) = 54000 / 66466 = 0.8124
- Remaining Fraction = 1-0.8124 = 0.1876
- Remaining hours = Remaining fraction * Design Life Hours
- Remaining hours = 0.1876 *100000 = 18760 hours