Introduction to sodium technology – Physical properties of sodium

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1 Quiz

1.1 Questions

1. Which one of the following is not a desirable characteristic of coolant?
(a) high thermal conductivity (b) low viscosity
(c) low specific heat (d) high density

2. With increase in temperature, the viscosity of liquid sodium
(a) increases (b) decreases (c) does not change (d) depends on composition

3. The low volumetric specific heat of Helium is attributed predominantly to
(a) higher specific heat (b) lower density
(c) higher density (d) lower specific heat

4. For a fixed flow rate at 300 °C, which one of the following requires the highest energy for pumping?
(a) lead (b) sodium (c) helium (d) lead-bismuth eutectic

5. Calculate the Prandtl number for sodium at 300 °C?

6. Which among the following coolants has the highest Prandtl number?
(a) sodium (b) lead (c) helium (d) lead-bismuth eutectic

7. Determine the average specific heat of sodium between the temperatures 300 °C and 500 °C.

8. You are required to calculate the average specific heat of liquid sodium over a temperature range of 300 °C to 500 °C. Your friend suggests a simplified method in which the specific heat of sodium at 300 °C and 500 °C are to be calculated separately and their arithmetic mean taken as the average specific heat. Evaluate his suggestion by comparing with the answer obtained for the previous problem.

1.2 Answers

1. (c) low specific heat

2. (b) decreases

3. (b) lower density

4. (a) lead

5. Prandtl number = Pr= $c_p\mu/k$

Pr = 1300*0.34*0.001/76 = 0.0058

6. (a) sodium

7. Average specific heat of a material over a temperature range T_1 to T_2 can be calculated as follows:

$$\overline{c_p} = \frac{1}{(T_2 - T_1)} \int_{T_1}^{T_2} c_p dT$$

$$\overline{c_p} = \frac{1}{(T_2 - T_1)} \int_{T_1}^{T_2} (1436.715 - 0.5805T + 4.6273x10^{-4}T^2) dT$$

$$\overline{c_p} = \frac{1}{200}[(1436.715T - 0.5805T^2/2 + 4.6273x10^{-4}T^3/3)]_{300}^{500} = 1280\, J/kgK$$

The average specific heat of liquid sodium over a temperature range of 300 °C to 500 °C is 1280 J/kgK

8. As per the friend's suggestion, specific heats have to be calculated separately for 300°C and 500 °C.

Using Eq. (3), specific heat at 300 °C is 1304.22 J/kgK & specific heat at 500 °C is 1262.15 J/kgK. The average value is 1283.18 J/kgK.

Comparing this with the answer for the previous problem, the error is 0.24 % low enough to neglect the error.

Hence the method suggested by the friend can be accepted.