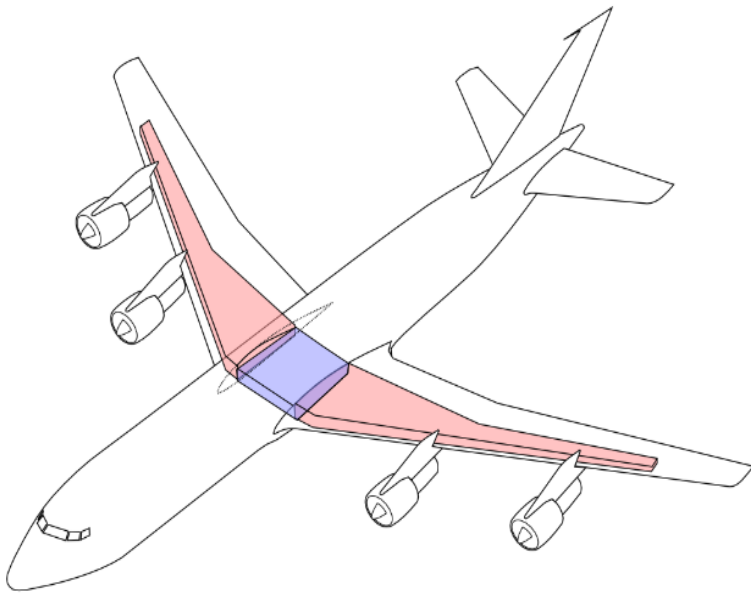


Airplane Fuel Tank Heat Transfer

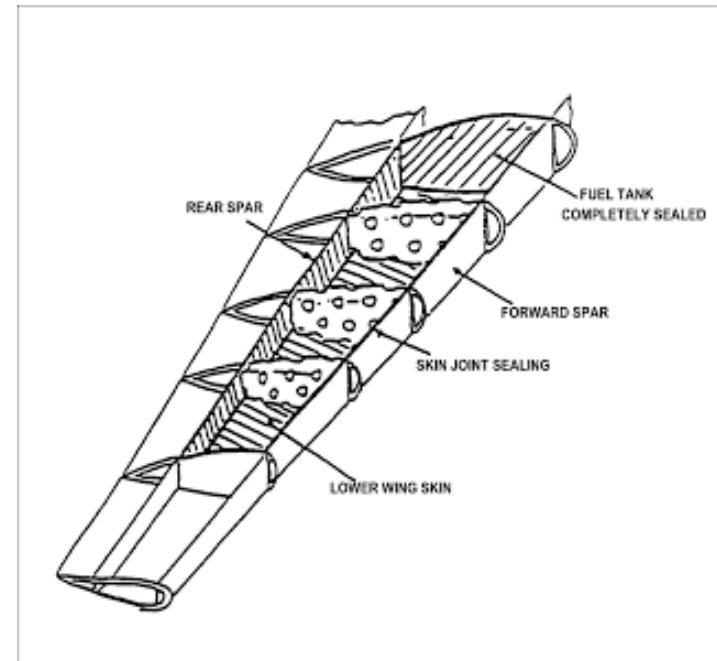
Brad Olmstead
April 1, 2015

Airplane Fuel Tanks

Typical Commercial Airplane Fuel Tanks

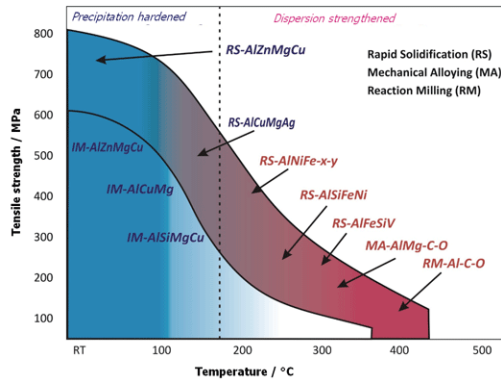


Tanks Integral to Wing

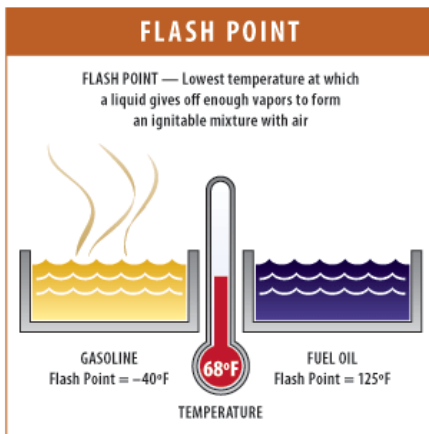


Fuel Tank Thermal Issues

Wing Strength



Flammability



Freezing

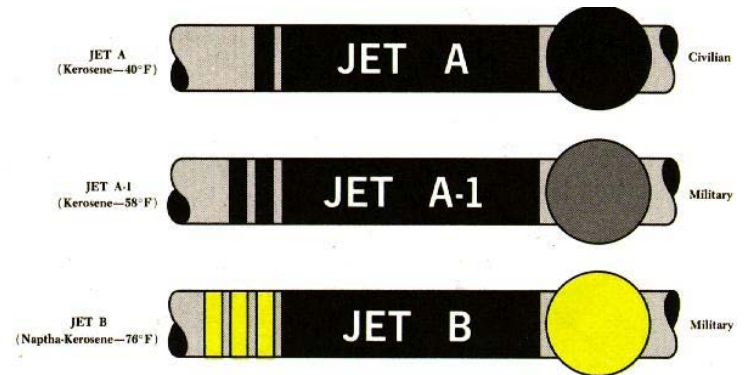


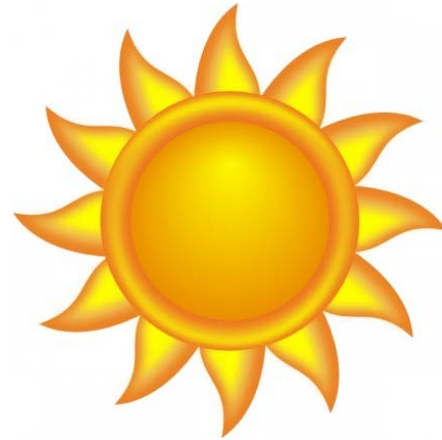
FIGURE 4-3. Identification of jet fuels.

Fuel Tank Heat Sources

Hydraulic Heat Exchanger



Solar Heating



Fuel Pumps



Heat Transfer Problem

- How much hydraulic heat, in Btu/min, can be put into the fuel tanks without going over the fuel tank temperature limit of 140°F?

Typical Thermal Analysis Process

- **Meet with customer (negotiate dates and scope)**
- **Collect reference materials**
- **Formulate methodology and assumptions**
- **Determine what boundary conditions will be needed**
- **Select tools/applications**

- **Do analysis**
- **Peer review**
- **Customer review**
- **Publish results**

Heat Transfer Problem

The conditions of concern are:

- In-flight cruise, at 35,000 ft, Mach 0.8, static air temperature -5°F
- Ground operation, at sea level, no wind, static air temperature 120°F

Assumptions

- 1) The sun is directly overhead on a clear day.
- 2) The sky temperature is -50°F , and the ground surface temperature is 120°F .
- 3) The fuel tanks can be approximated as rectangular with dimensions of (10' X 60' X 2' deep).
- 4) The 4 vertical surfaces of the fuel tank are thermal insulated (adiabatic).
- 5) The upper and lower wing skins are made of either carbon fiber reinforced plastic (CFRP) or aluminum, about 0.4 inches thick.
- 6) The fuel tank temperature limit is 140°F .
- 7) The tanks are full of Jet A fuel (kerosene)
- 8) The airplane wings are level.
- 9) For the purpose of thermal analysis, the fuel temperature can be assumed to be at one bulk temperature (no temperature gradient in the fuel)

Heat Transfer Results

Condition	Maximum Hydraulic Heat Load (Btu/min)
CFRP wings, in-flight	?
CFRP wings, on the ground	?
Aluminum wings, in-flight	?
Aluminum wings, on-the ground	?

Questions?