(3) Cooling capacity checking methods

1) Air-to-boil (ATB) test

ATB is a quick and easy method to determine a machines present cooling efficiency and help predict the cooling performance at elevated ambient temperatures.

[Test equipment]

- Temperature meter or data collector and at least 6-thermocouple probes and 4-optional probes
- A 50/50 mixture of Ethylene Glycol anti-freeze must be used in the engine
- 88.2 kPa {0.899 kg/cm^2 (12.8 psi)} rated radiator cap installed
- Blocked open thermostat
- Engine tachometer

[Test conditions]

(a) Ambient temperature of at least 24 deg. C (75 deg. F) is required for accurate testing.
If outside temperature is below 24 deg. C (75 deg. F) testing must be completed in a heated room.
- Testing in temperatures below 24 deg. C (75 deg. F) or in high winds might produce inaccurate results.
- Ambient temperature readings should be taken approximately 3 m (9.8 ft) from the machine.

(b) Machine must be tested at a duty cycle that represents the worst case scenario that the machine will be used in the field.

(c) All machine enclosure panels, screens and fan shrouding must be in place.

[Test setup]

1. Install blocked open thermostat.
2. Install thermocouples to record the following data.
   a. Radiator coolant in (Top tank)
   b. Radiator coolant out (Optional but recommended)
   c. Air cleaner inlet air
   d. Engine oil
   e. Exhaust gas
   f. Engine speed
   g. Ambient
   h. Radiator air in (Optional)
   i. Compartment air (Optional)
   j. Radiator air out (Optional)
   k. Hydraulic oil (Optional)

Note:

- **Engine speed and exhaust temperature is required to estimate the engine loading.**
- **Radiator coolant temperature readings must be taken in the coolant stream.**
- **Ambient temperature readings should be taken 3 m (9.8 ft) from the unit.**
- **Oil temperature should be taken in the oil pan as close to the center as possible.**

3. Operate the unit at its most severe operating condition until the coolant temperature is stabilized (does not change more than 2.0 deg. C (36 deg. F) in 15 minutes).
   Stabilization usually takes place after operating the engine for 45 minutes to 1.5 hours under loaded condition.
4. Record data in small time increments until stabilization temperature is reached.
5. To calculate ATB
   88.2 kPa {0.899 kg/cm^2 (12.8 psi)} radiator cap

   ATB (Air-To-Boil) = (A-B) + C

A = Theoretical coolant boiling temperature or maximum allowable coolant temperature
- 110 deg. C (230 deg. F) is Kubota's maximum allowable coolant temperature with a 88.2 kPa {0.899 kg/cm^2 (12.8 psi)} radiator cap.
  If a 48.3 kPa {0.447 kg/cm^2 (7.00 psi)} cap is used, substitute 104 deg. C (219 deg. F) in place of 110 deg. C (230 deg. F).

B = Top tank or engine coolant out line temperature (Thermostat fully open)

C = Actual ambient temperature recorded during test

Example: A D722 using a 88.2 kPa {0.899 kg/cm^2 (12.8 psi)} radiator cap running in a turf tractor under severe operating conditions.
The top tank coolant temperature was measured at 90.0 deg. C (194 deg. F). The ambient was recorded at 29 deg. C (84 deg. F). Therefore;
ATB = {110 deg. C (230 deg. F) - 90 deg. C (194 deg. F)} + 29 deg. C (84 deg. F)
= 20 deg. C (68 deg. F) + 29 deg. C (84 deg. F)
= 49 deg. C (120 deg. F)

[To evaluate ATB]

Kubota's minimum allowable ATB is 49.0 deg. C (120 deg. F).
An ATB below 49.0 deg. C (120 deg. F) indicates limited cooling reserve.
Using the above example, the ATB of 49.0 deg. C (120 deg. F) means that if the ambient temperature would rise from 29 deg. C (84 deg. F) to 49.0 deg. C (120 deg. F) then the top tank coolant temperature would rise to the maximum allowable of 110 deg. C (230 deg. F).
- The ATB is the maximum ambient temperature which the machine can operate in and not exceed Kubota's maximum coolant temperature.

The equipment manufacturer should determine the unit's anticipated operating ambient and design the cooling system to provide for proper cooling under all potential operating conditions.
Since it is not always possible to test the application at the highest anticipated ambient, a higher than 49.0 deg. C (120 deg. F) ambient should be the target.