Improving the efficiency of an engine cooling system using electrical fans

A comparison between Electrical and Hydraulic fans

How has your work contributed to solve a problem related to energy that exists in the world or in society?

Transportation is one of the **largest consumers of energy** it represents **20% of the world's energy**.[1] So complementary to finding alternative energy sources, making transportation more energy-efficient is also a big priority. This is the focus of this thesis, which analyses engine cooling, still done through old hydraulic fan technology, but that could be greatly improved. Even ***a small improvement*** here would have a ***massive impact*** considering **all the energy**, that all the cooling systems from all the buses in the world spend, especially considering developing countries where these are in greater use, and in a significant amount of cases have to deal with extreme weather thus requiring **an even better system**.

[1] http://www.eia.gov/tools/faqs/faq.cfm?id=447&t=1. U.S. Energy Information Administration

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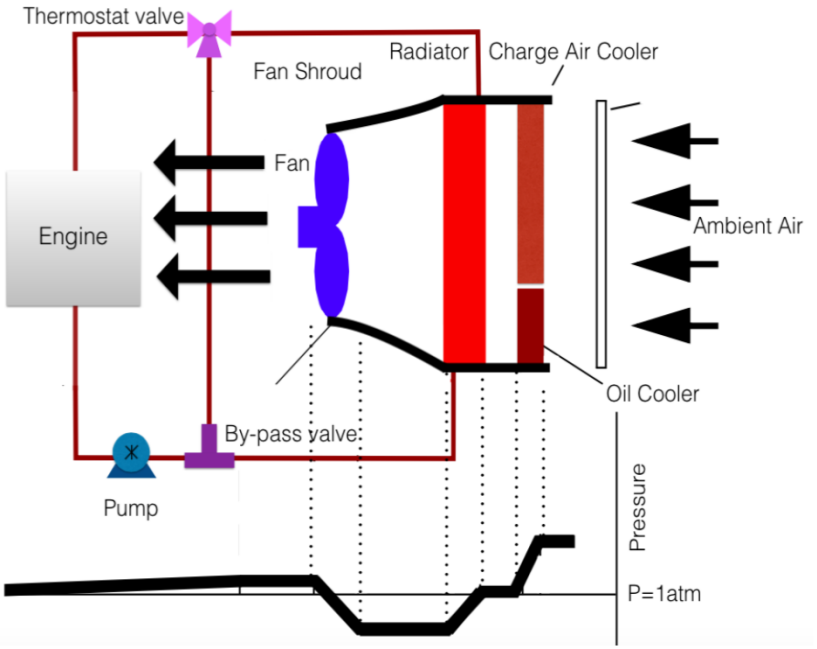
Hydraulic fan vs Electrical fans

- A **single** large hydraulic fan is the **mainstream** solution to cool bus-engines.
- @ 3600 rpm, **1** hydraulic fan requires **16 kW** to cool the engine.
- **5** smaller electrical fans do the job, using just **3 kW**



Plus, a hydraulic fan requires a water pump and an oil cooler, which is placed in front of the radiator and charge-air-cooler (CAC)

→ Less air available to cool the radiator
→ Worse fan shroud (mounting) design for hydraulic fans
→ Electric fans have lower idling speeds a nd are independent of the engine speed

Improving the Electrical Fan Cooling Solutions

Fan shroud design

→ How much fan power (with electrical fans) do we gain or loose with a hydraulic fan shroud?

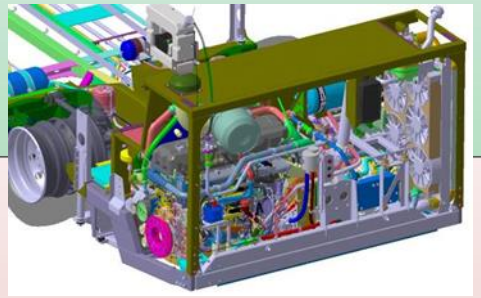
Cooling Performance (LAT, IMTD)

→ Changing LAT demand +4°C and -4°C

→ Changing IMTD demand +2°C and -2°C

INVESTIGATION

→ How the electrical power will vary with the following changes



Oil Cooler Deleted

How much do pressure drop and heat affect fan power?

→CFD with and without oil cooler: effect on air temperature into radiator, air flow and air speed distribution over RAD surface

Built-in-Resistance

→ What happens if we change from sandwich to separated with radiator on roof and CAC in engine compartment.

Results

- **Reduced** fuel consumption (-4%)
- **More efficient** use of energy: better control of the fan speed
- Lower noise levels
- Possibility for integrating the fans with GPS so that these can **optimize operations** in anticipation of situations of higher cooling demand
- 30 kg lighter
- No need for an oil cooler → **less 20%** air flow required
- Since they are multiple, the air flow is more evenly distributed across the radiator – possibly increasing lifetime of the equipment
- For some markets, bigger and more powerful fans are needed but not available yet