Is R & D in small-turbine design still needed?

An example of ongoing laboratory development based on systemisation.

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Small hydro power plant

A small hydropower plant is a plant which, for technical and economical considerations, must not be the geometrical reduction of a large one

Small hydro development

The cost of developing a test model is of the same order of magnitude as that of a complete small hydro turbine

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Independent manufacturers of small hydro turbine

cannot afford this laboratory work

Small hydro and high efficiency

High efficiency is important even for small hydro, because :

- The efficiency mirrors optimal hydrodynamic performance
- Guarantee the future production and the turbine reliability and operation
- The efficiency required for one 100 MW turbine is no less justified when dealing with fifty 2 MW turbines.

Output control at site

- Not easy to implement and costly
- Method frequently unsuited to small installations
- Always questionable
- Generally no possibilities to improve the turbine if guarantees are not reached
- Penalties never compensate for the loss of production

Output control - Laboratory tests

- Tests on turbines geometrically similar to the prototypes
- Transposable results are obtained (according to international standards)
- Possibility to correct the possible shortcomings before the prototype is built
- High cost

Succes criteria

The key words for a successfullly project are :

- Simple construction to ensure economical and constructional feasability for SME
- High energy efficiency
- Maximum reliability ans easy maintenance

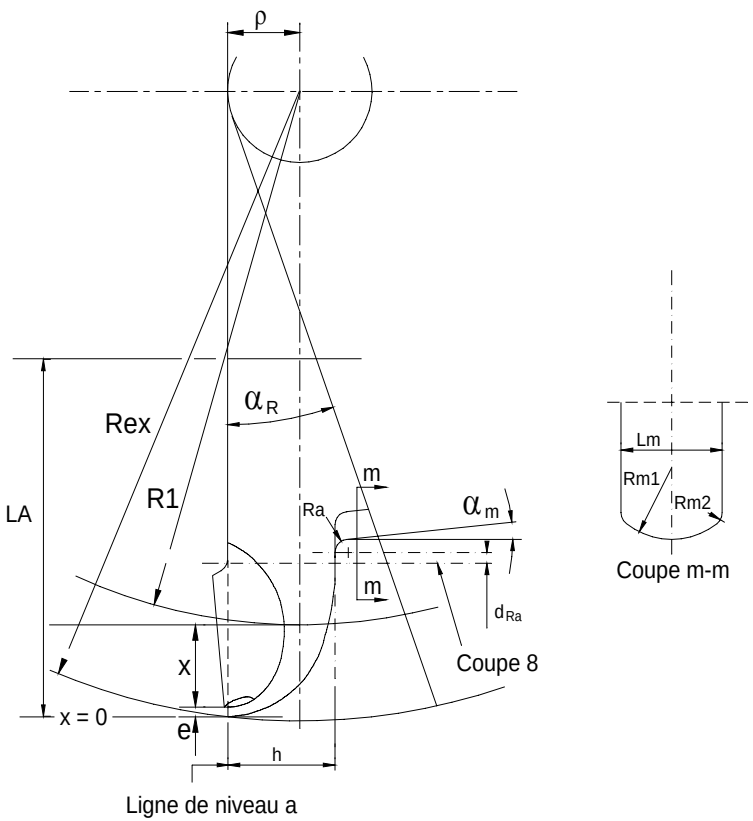
The Systematisation Method

- Entire parameterisation of the turbine's hydraulics.
- Test of the behaviour and performances as a function of the parameters.
- Offers the possibility to design individually each new turbine in function of the exact characteristics of the site to equip.
- Same efficiency and performance guarantees as for large hydro, even for Pm < 1'000 kW

The Systemisation method (Basic principle)

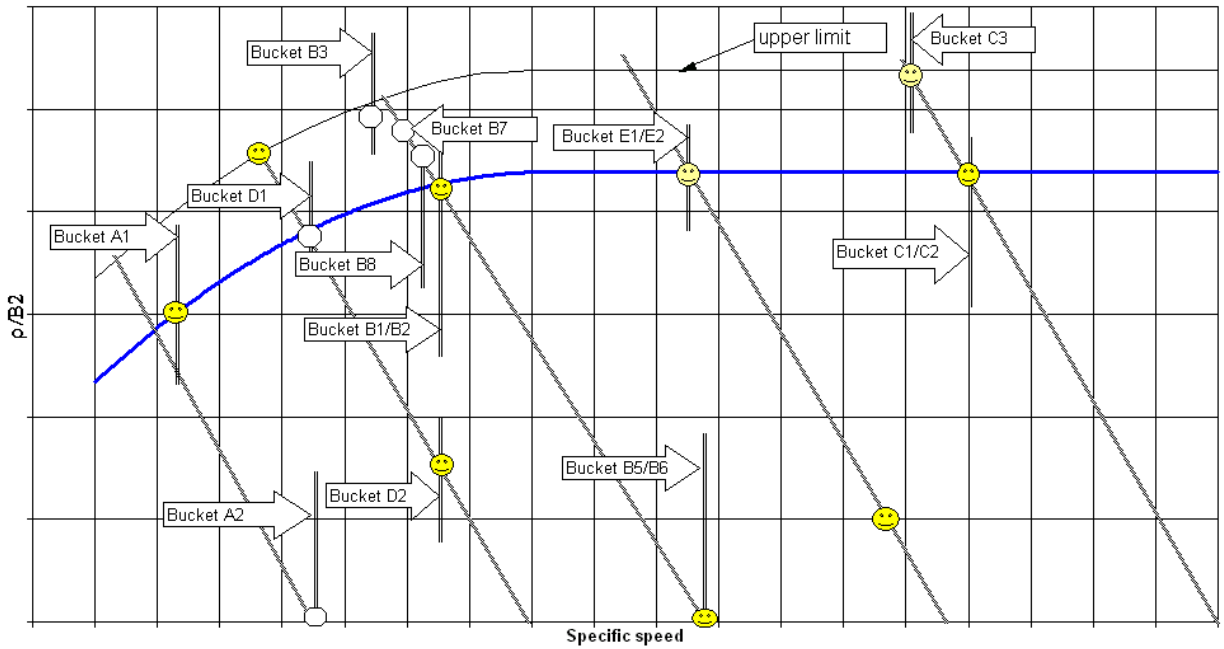
- Simplification of hydraulic forms, and use of commercially available parts.
- Measure of the impact of these simplifications on the test bench.
- Direct or indirect parameterisation of all hydraulic forms, function of the site's data.
- Development of mathematical and computer tools.

The Systemisation method (Presentation of the process)



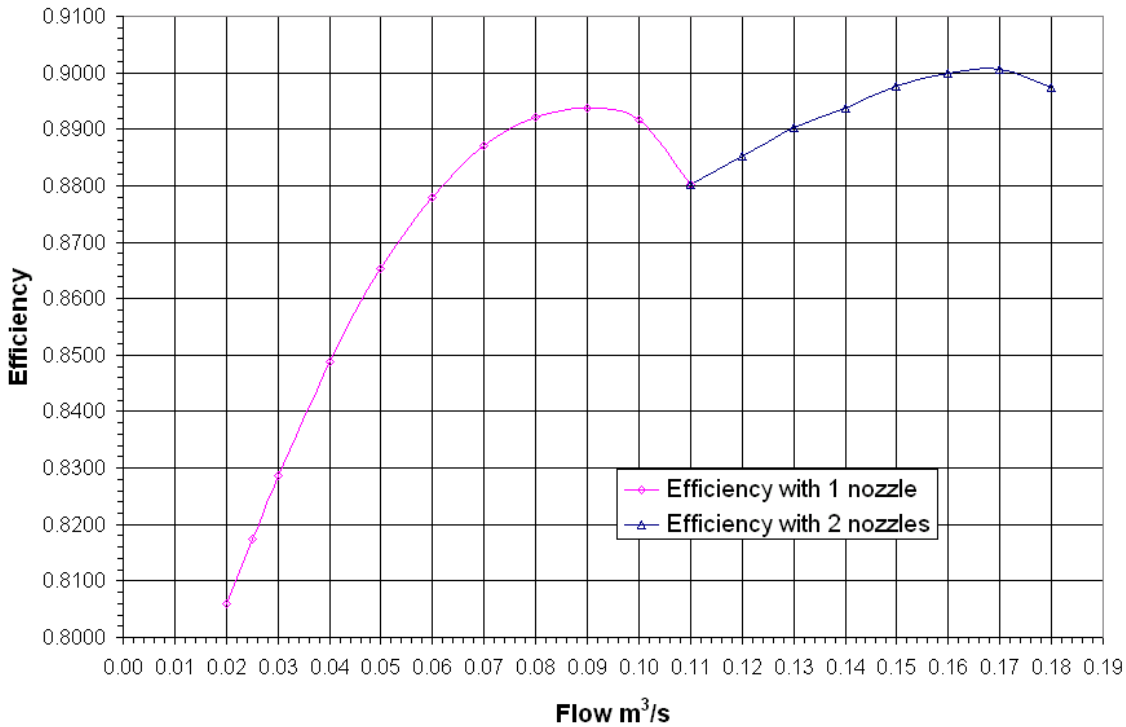
The first step consists in determining within what specific-speed limits, a given bucket topology can adapt to the flow by varying runner construction parameters.

The Systemisation method (Presentation of the process)



Variation of the eccentricity ρ of a Pelton runner in function of the specific speed (principle diagram)

Performance guarantees

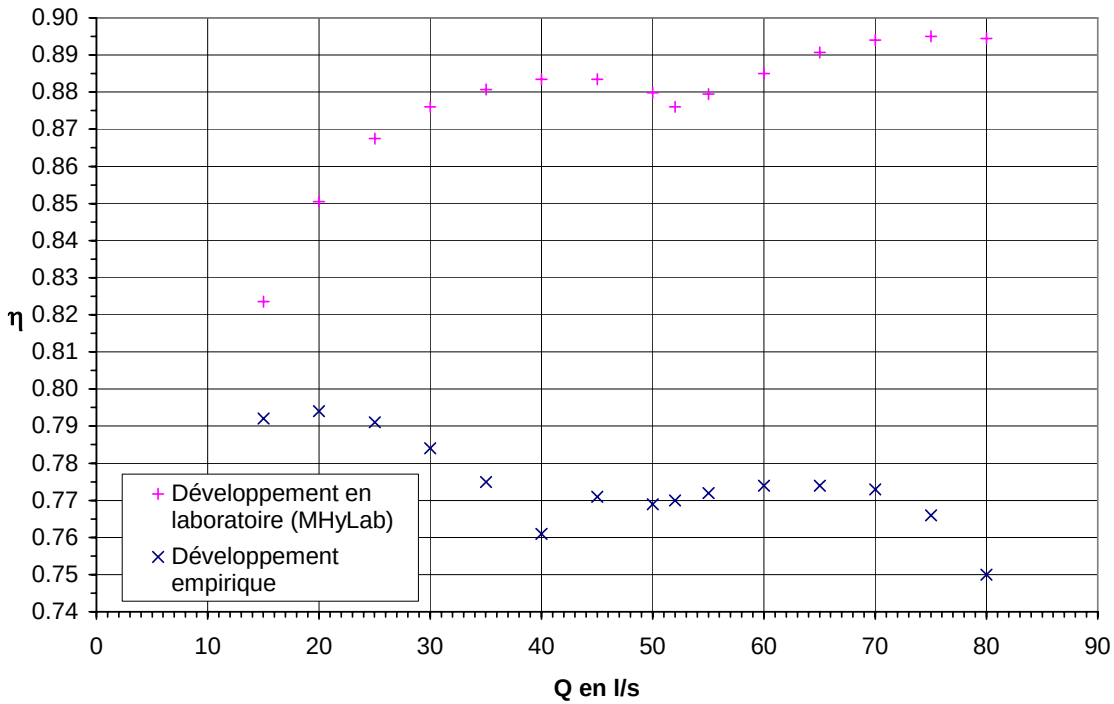


Efficiency guarantees (from laboratory tests), for La Rasse small HPP

Advantages of the method

- Turbine simple to be manufactured and maintained
- Optimal Hydrodynamic performance(high degree of operation security)
- Respected efficiency and power guarantees
- Cost savings on design
- Turbine delivery-time reductions
- Perfect compliance of the machine to the site's characteristics.

Advantages of the development in the laboratory

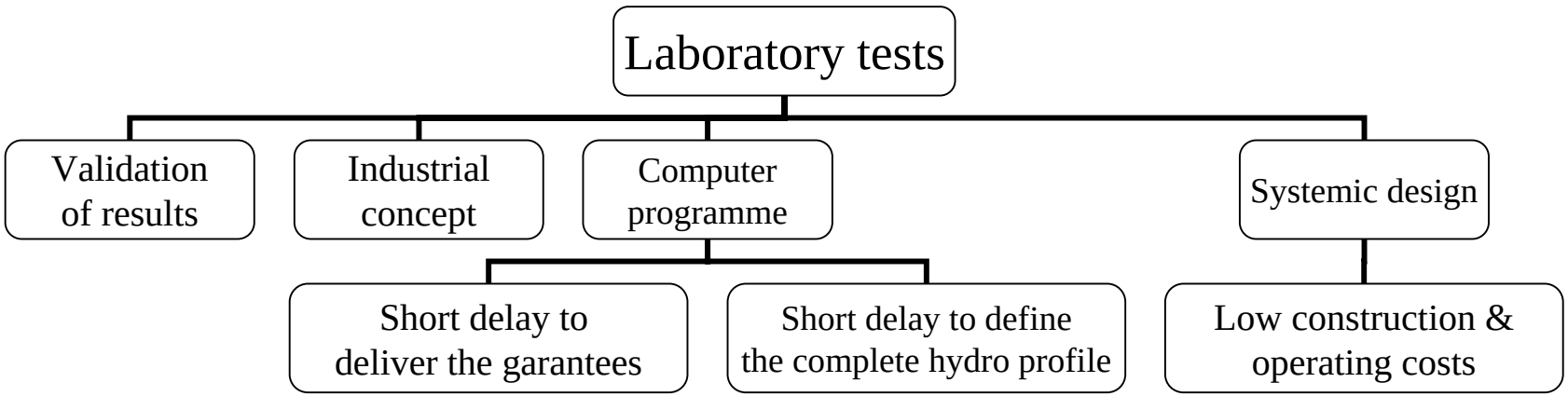


- 1 Pelton turbine, 2 nozzles
- H_n : 479 m
- Q_{max} : 180 l/s

Small HPP Pas-du-Lein (CH)

- 1 Pelton turbine, 2 nozzles
- H_n : 299 m
- Q_{max} : 180 l/s
- $P_{méc\ max}$: 470 kW
- Manufacturer : GASA SA (Switzerland)

Some R&D objectives



To provide small independent turbine **manufacturers** with an **efficient and guaranteed technique in a short delay, and with low costs**.

Conclusions

- Important work is performed to develop systemisation method.
- As for many other fields (electical equipment, control and monitoring systems, civil work, these examples show that R&D is still needed for small hydro.