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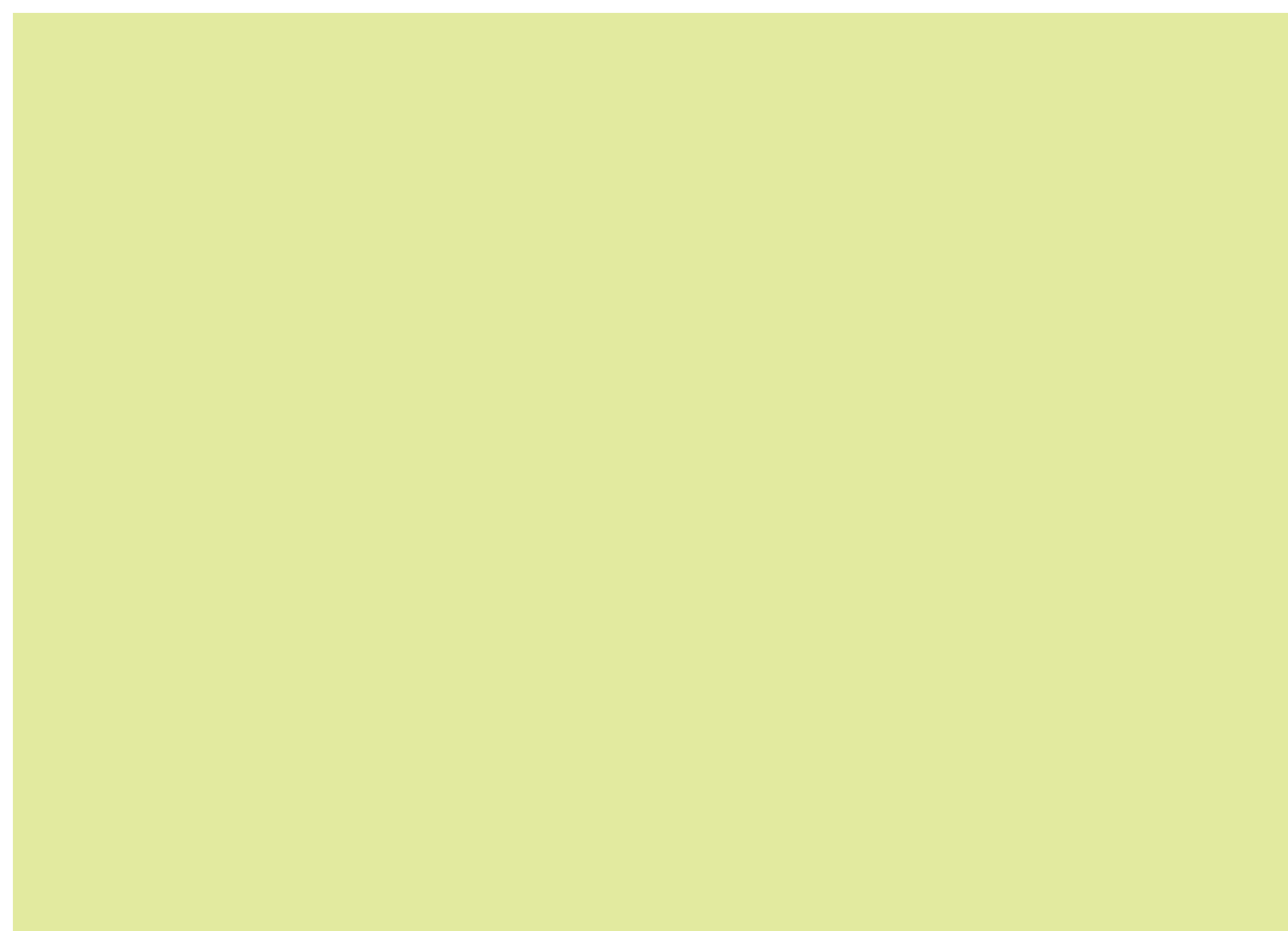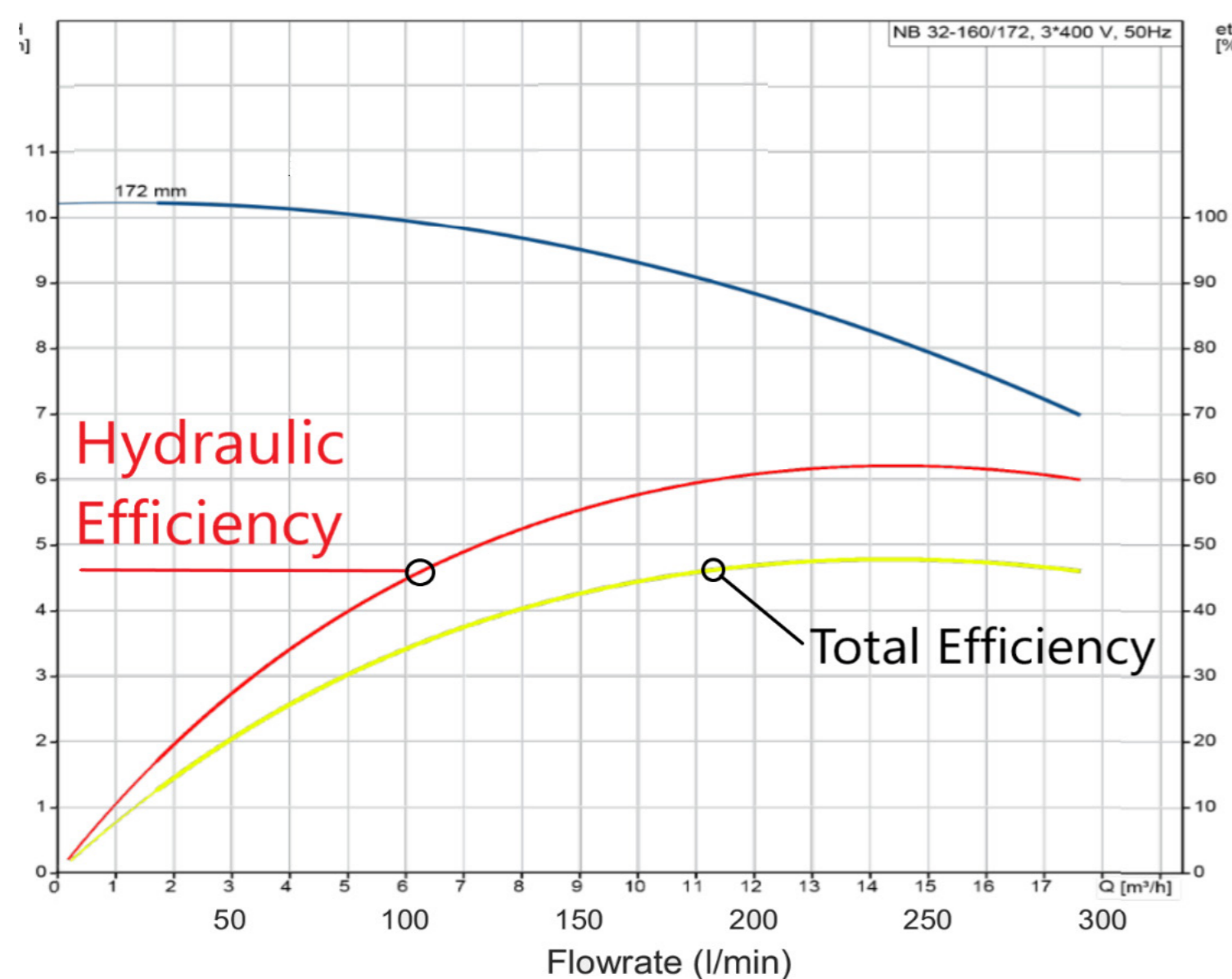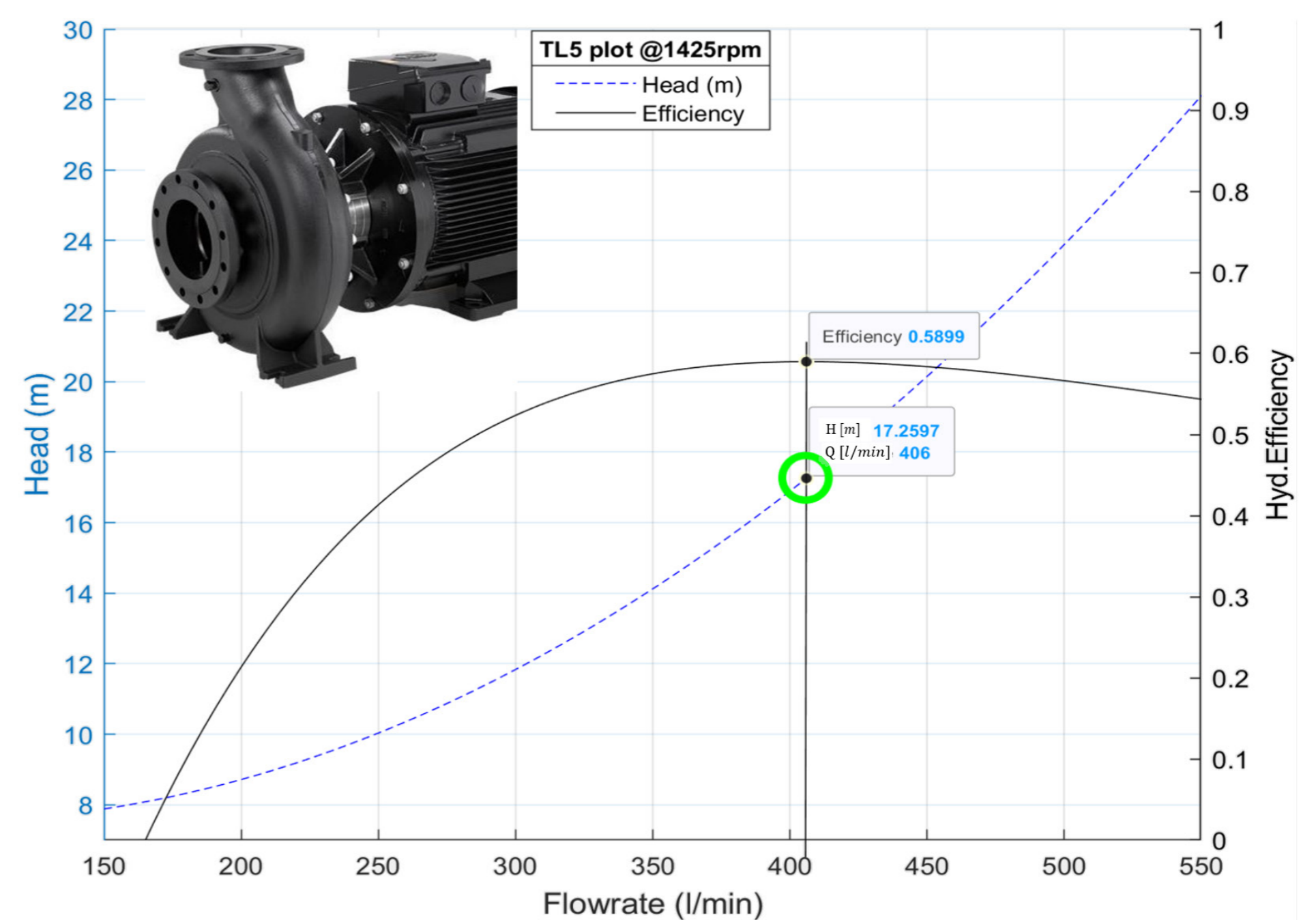**Bachelor's thesis in Energy Systems Engineering**

PAT performance measurements & generation of mode characteristics

Manufacturer Data
Pump Characteristics

Predicted Turbine Characteristics

PAT performance measurements & generation of the turbine mode characteristics from pump mode data

Background
Renewable energy sources are increasingly used to replace coal and nuclear power plants. Hydraulic turbines are proven to be a beneficial solution because their power production is less fluctuating than other renewable energies.
However, the equipment cost shares of conventional hydro turbines are in micro hydropower schemes about twice as high as in large scale schemes.

Pumps as Turbines
Using Pumps as Turbines (PATs) is especially beneficial for Pico to small scale hydro power plants where the equipment cost determine whether a project is economically viable or not. Pumps are mass-produced globally, easy to maintain and have low in-

stallation cost.
Considering the installation of a PAT instead of a conventional turbine can reduce the payback period by an order of 5 to 1 or even more.

The issue
Despite the benefits associated with the use of PATs, their share in the hydro turbine market until now has been negligible.

The main problem of using PATs is still the difficulty of predicting accurately the turbine performance, because the pump manufacturers do only provide the pump characteristics.

Analytical methods
Analytical methods that allow to predict the turbine peformance based on the provided pump data, are demanded by the designers of small hydro schemes.
In order to address this issue, recent stud-

ies propose methods to predict the turbine characteristics from the manufacturer data. However, so far there is no perfect method that can universally be applied on any pump.

Goals
This paper examines current PAT prediction methods with respect to their applicability within the hydro power industry. The development of a program that can be used to predict and plot the turbine characteristic curves of centrifugal pumps is an integrated part of this work.
A demonstration of the program is provided where the predicted turbine characteristic curves of a centrifugal pump were plotted. Moreover, an evaluation of the predicted characteristics based on performed PAT measurements is provided.

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