Grundfos: Method to check distance to catalog curve.

Motivation:

In order to verify a pumps performance a number of measuring points are compared to a catalog curve.



Figure 1: Typical set of catalog curve for a pump

To quantify the difference between the measured points and the catalog curve, we want to calculate the shortest distance between the point and the curve.

The shortest distance between a point and a curve is defined as the smallest mean square distance between the measured point and a point on the curve in a normal-ized coordinate system. The normalization is made with reference to the nominal duty point of the pump. In addition the distance has a sign. The sign is positive if the point is above the curve and negative if the point is below the curve.

Present method:

At the moment Grundfos uses a method that depends on a partial linear curve and an inverse Schwartz-Christoffel transformation. The transformation moves the curve to the positive x-axis. The area above the curve in 1. quadrant moves to the full 1. quadrant and the area below the curve moves to the 4. quadrant.

This way the new coordinate set for the point will have the desired characteristics.

The method is used to measure a relative distance between a measured point and a catalog curve. The tolerance is relative in the three variables flow, head and power consumption. Relative distance is defined as the distance to the catalog curve di-vided by the distance to the tolerance curve on the same side of the catalog curve as the measured point.



Figure 2: Piecewise linear catalog curve with tolerances

Problem:

We want a method that can handle a more general description of the curve. First of all a polynomial description.