Tips for a Perfect Turndown

Are exceptionally high values a good sales point?

It's a proven fact, that a larger turndown of a process instrument isn't to be compared to a better performance in any case. This article specifies all that matters concerning the interpretation of the data sheet and the definitions.

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Tank measurement with a process transmitter

Pictures: Wika

Turndown — this feature in a process instrument represents one difference, and maybe even the most important one, between a pressure transducer and a process transmitter. In pressure measurement, this is often the decisive argument why users will prefer a process transmitter for particular measuring tasks: It gives them the possibility to set the measuring span or scaling individually. The instrument is programmed in such a way that it only monitors the measuring range that is relevant for the process.

In most instances, the manufacturer supplies a sensor with the start of the measuring range at 0 bar relative or absolute. However, those values within the lower pressure range are sometimes not the focus of the plant monitoring. For example, an operator might only be interested in the upper 20 % of a measuring span, since a safety shutdown might need to be triggered at higher pressures, while lower pressures never occur in the course of the process. Being able to set the sensor so that this upper range is covered by the full span of the 4...20 mA signal is only available with process transmitters and not with pressure transmitters.

Turndown To Simplify Logistics

The turndown capability also brings a logistical advantage: Service departments require only one product of the same model in a standard design, which can then be matched to the respective process pressure using the turndown. In addition, faults can be resolved immediately with instruments from stock: It only needs minimal setting in the laboratory or workshop in order to make a replacement available in the event of a sensor failure.

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In view of these features, turndown can be considered as a promising sales argument. Under increasing competitive pressure, manufacturers of process instruments are quite obviously positioning themselves behind the sports motto of "higher, faster, further" in order to get the maximum possible attention from potential customers. Especially high figures for turndown are specified in data sheets, so that the particular instrument will stand out with the direct comparison of specifications.

This strategy often works out. In general, it is not the buyers who specify the measurement technology for a plant. They order against the specifications which the planning engineers have established for the process instruments to be used. When determining who should put together which package for the process instrumentation, in recent times the specification of the turndown has been evolving as the factor to tip the scales. For example, one manufacturer states a figure of 20:1 in a bid, a competing company might however push 300:1, so the buyer will think about it and eventually—based on the numbers—go for the supposedly higher-performance instrument. The actual needs or application requirements can thus be easily lost out of sight.

When Does a Turndown Makes Sense

However, with turndown, does "more" necessarily mean a "better" product? In order to answer this question, one must bear in mind the objective of any scaling—to utilise the measurement signal in the optimal way, from the start to the end of the measuring range. As an example, we can look at the monitoring of a tank. The operator wants to ensure that half of the tank contents is always available as a reserve, but on safety grounds the level must always be at least 20 % below the maximum. Thus, the required measuring range is between 50 % and 80 % of the maximum filling height. For this application, the operator will select a measuring instrument that can monitor the complete filling level—for example, ten metres or approx. 1,000 mbar. So the appropriate process transmitter for this can cover a pressure range of 0 to 1,000 mbar. However, only a filling level of 50 % to 80 % is relevant, so the scaling would be set to correspond to 500 mbar to 800 mbar, or one can say to a measuring span of 300 mbar. The turndown required for this is calculated as the ratio of the basic measuring range (1,000 mbar) to the scaled measuring range (300 mbar)—so here 1,000:300 or 3.3:1. So the output signal will be measurable as 4 mA at 500 mbar pressure and 20 mA at 800 mbar pressure. These are the physical limits with an analogue output or with a 4...20 mA signal overlaid with a Hart bus signal (see diagram next page).

The example chosen here is actually based on practical experience and should demonstrate why turndown is useful in many cases. Compared to the possible basic measuring

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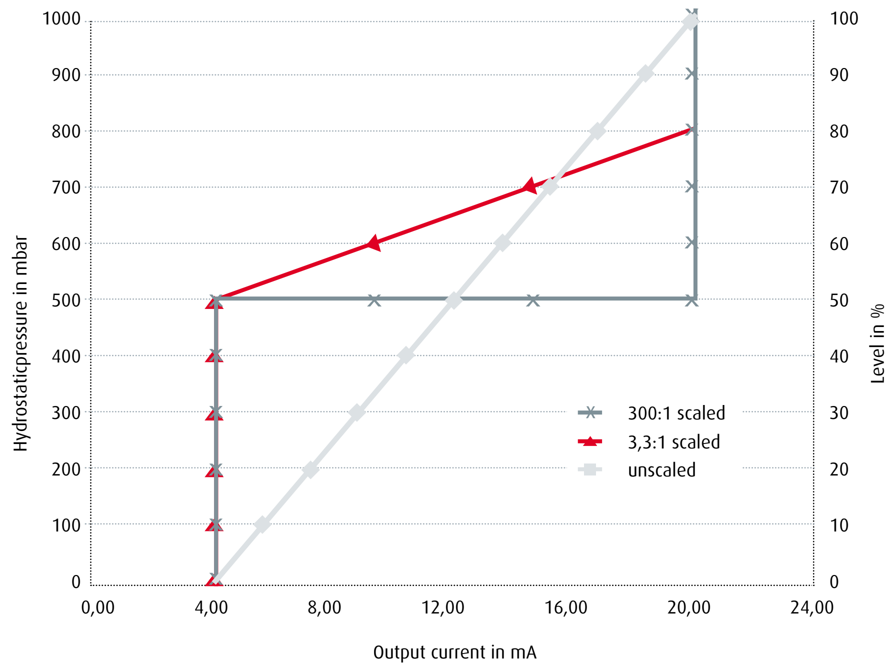

Pressure-current diagram with possible output characteristics

range of the instrument, the scaled range, at about one third, is relatively small. It would almost be minimal if one had taken a turndown factor of 300:1. Translated into the tank example, with a possible pressure profile of 1000 mbar, at 300:1 the operator would thus be wanting to measure just about 3.3 mbar. In other words, a maximum measuring height of ten metres would shrink to a total of 33 mm.

Why to Take Measuring Accuracy into Account

One aspect which must not be forgotten with a turndown deliberation is the measuring accuracy of the process transmitter — this reduces proportionally with turndown. Let us assume that the tank operator decides for a high-quality transmitter with an accuracy of 0.1 % of the measuring span. Then, with his turndown of 3:1, he would already have a maximum permissible error of 0.3 % with respect to the set scaling. Converted into the level height, this gives an inaccuracy of 3,000 mm x 0.33 % = ±10 mm. In the context of the level measurement, this would give a measuring result that would be completely acceptable and normal. With some process transmitters a turndown of up to 5:1, with respect to the measuring accuracy, is stated as neutral. For this, however, in the case of the tank example, one would need to go for a measuring cell that was better by a factor of 5, in order not to exceed the permissible error of 0.1 % of the entire measuring range, i.e. for a sensor with an accuracy of 0.02 %.

That a scaling in no way improves the measuring characteristics of a transmitter is particularly true when one translates the extreme turndown of 300:1 back to the tank example. Here, one would have to tolerate an error of 33 % of the set measuring range, which is to say an error of 11 mm in a measurable filling height of 33 mm. In practice, one can no longer speak of measurement in a case like this.

The quite widely-held belief that the larger the turndown in the data sheet, the better the performance of the instrument, is thus not automatically confirmed. What a number or ratio promises, may be possible to implement technically without problems. But whether it is actually suitable for the task in the process needs closer inspection. The selection decision for process instrumentation is complex, given the other basic factors that must be considered — environmental conditions such as pressure, temperature and humidity, the process conditions of temperature and vibration and the duration of application with possible wear. In comparison with these, the importance of turndown in the purchasing decision is put into perspective. In the end, only one thing must be ensured: to get exact measuring results — after an exact setting of all process parameters — which do not exceed an acceptable level of measurement uncertainties.