Process Insights™

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APPLICATION NOTE

Safe and Efficient Control of the Acrolein Process Using a ClearView® db Photometer

Acrolein (or propenal) is the simplest unsaturated aldehyde. It is a colorless liquid and is mainly used as a biocide or as a building block to other chemical compounds. It is produced industrially from propylene. In the end step of processing, acrolein is separated from water and other residual components by distillation. A simplified process diagram is shown in Figure 1. Measurement of both the water and acetaldehyde concentration in the final product is required. Acrolein is toxic and, without online analysis, hazardous manual sampling will be needed.

Near-infrared spectroscopy can provide the rapid, real-time, in-situ analysis required through the use of an inexpensive near infrared, dual beam, three wavelength photometer and a fiber optic coupled insertion probe. Tight control of the final water content and the acetaldehyde concentration in the acrolein final product is accomplished as the monitored results are transmitted in real-time to the process control system.
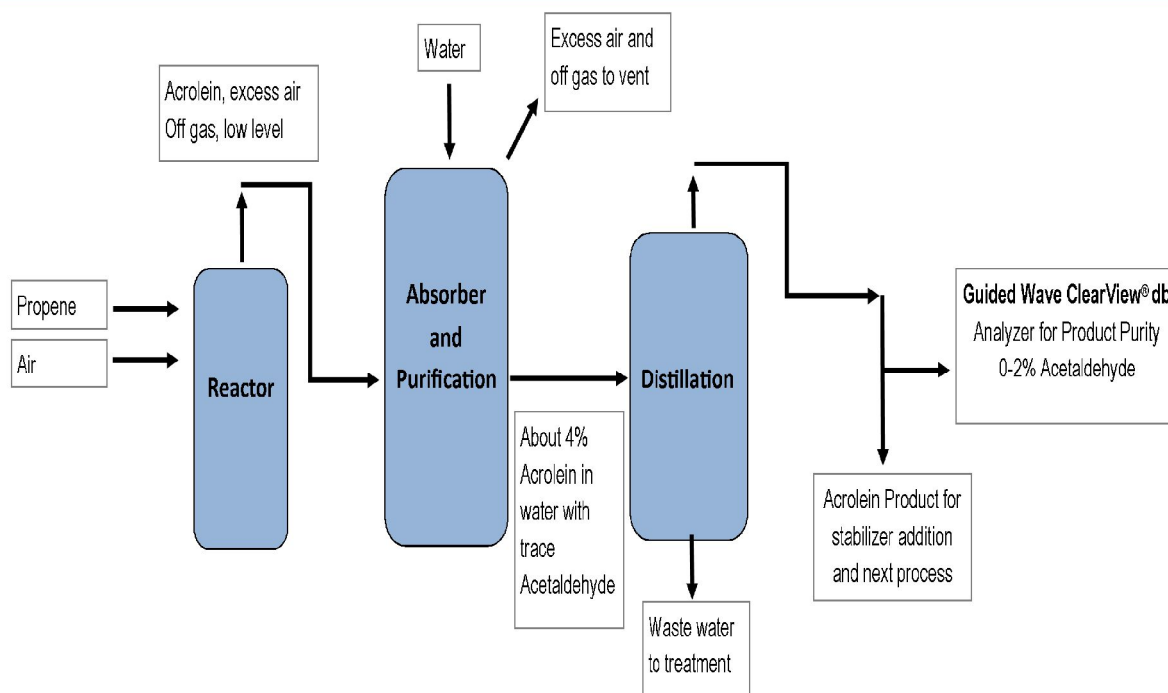

Figure 1: Acrolein Production Process Diagram

Measurement Background

The NIR region of the electromagnetic spectrum allows the use of the overtone and combination bands of the C-H, O-H, and N-H fundamentals. By measuring the NIR absorbance data for a series of acrolein samples of known water concentration, a quantitative model can be developed which will allow the measurement of future samples based only on their NIR absorbances. Our analyzer systems use fiber optics to allow the sample probe to be located in remote locations away from the spectrophotometer itself.

Experimental

A series of samples of known concentration ranging from 2% to 6% water in acrolein (Figure 2, Table 1) were used to demonstrate the measurement feasibility. Data for these samples was collected using a GUIDED WAVE™ 10 mm flow cell and a GUIDED WAVE ClearView® db photometer. The ClearView db was equipped with filters at 1301 nm, 1432 nm, and 1744 nm. These filters have been determined to be optimal for this measurement.

Analysis

The absorbance data for the acrolein samples is shown in Table 2. The data demonstrates a high degree of linearity when comparing the spectral data to water concentration. The data at 1301 nm was used as a baseline correction point for the other filter data. The data from the 1432 nm and 1744 nm filters was used in a linear regression model for water. The results are shown in Figure 3. The error for the water determination is approximately 0.03%. A similar data analysis for acetaldehyde was conducted and those results are shown in Figure 4.
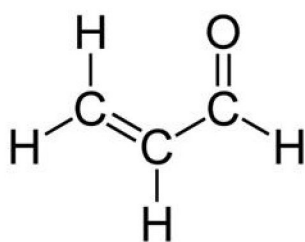

Figure 2: Acrolein

Sample ID	H_2O (%)
1	1.97
2	2.49
3	3.03
4	3.49
5	3.98
6	4.96
7	5.89

Table 1 Water Concentration

H$_2$0 (Lab)	1301 nm	1432 nm	1744 nm
%	AU	AU	AU
1.97	0.02695	0.30294	0.40165
2.49	0.02995	0.35660	0.40304
3.03	0.03176	0.42375	0.42375
3.49	0.03340	0.46730	0.42230
3.98	0.03558	0.53500	0.44300
4.96	0.03870	0.64717	0.46305
5.89	0.04400	0.76854	0.48477

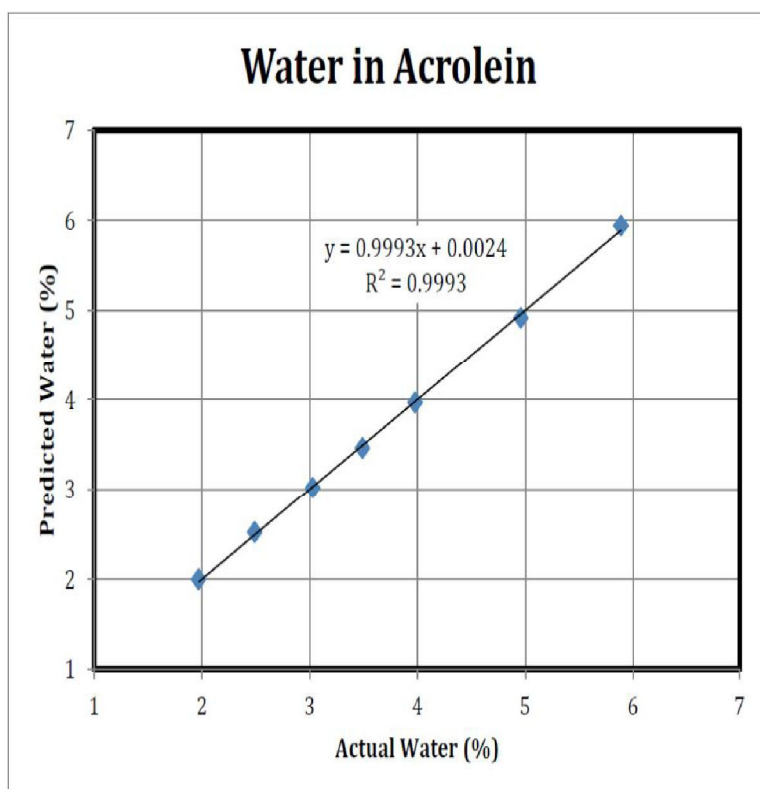Table 2 Water in Acrolein Absorbance Data

Figure 3: Water Results - ClearView db

Analysis

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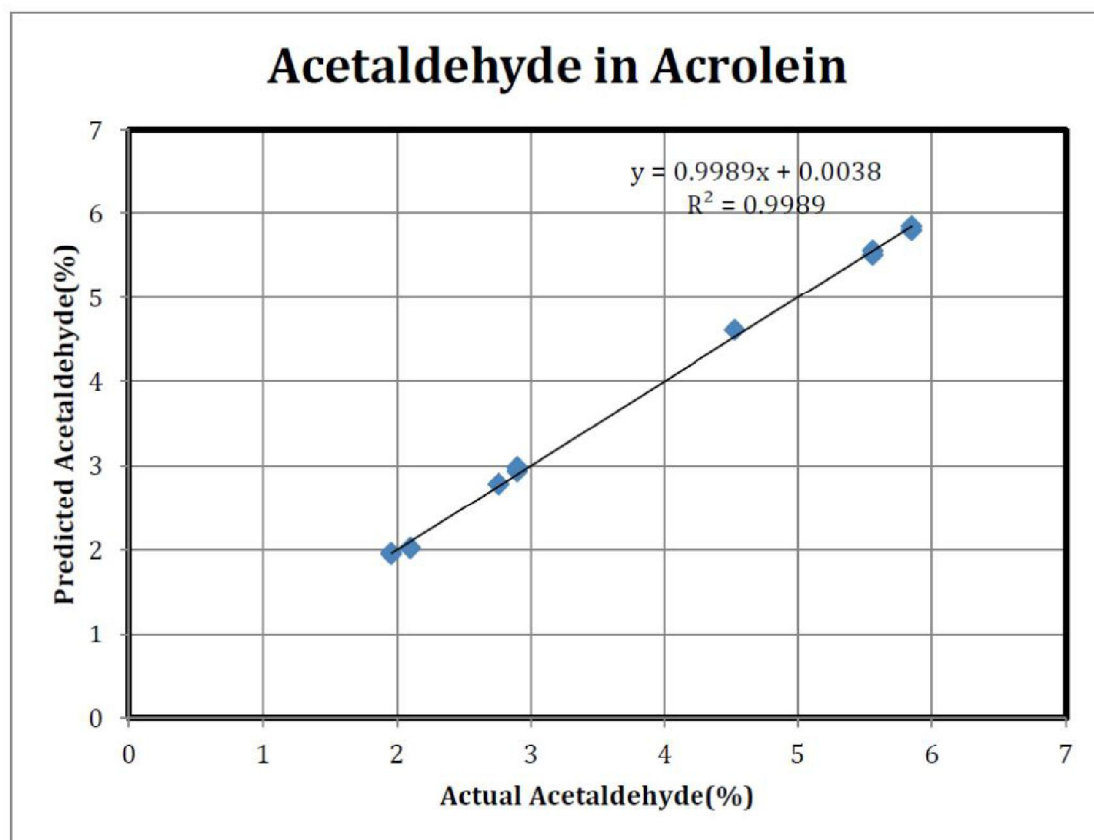
Figure 4: Acetaldehyde Results - ClearView db

Conclusion

NIR spectroscopy coupled with fiber optic probes provides an ideal online measurement solution for both water and acetaldehyde in acrolein in real time. For 1 or 2 sample points our ClearView db filter photometer can provide the measurement of low percentage levels of water and acetaldehyde in the final product. NIR methods minimize the need for laboratory sample collection. Results are available in real-time (seconds).

Acrolein is highly toxic, with online analysis using our ClearView db analyzer, manual sampling is avoided thus providing the safest and most efficient control of the Acrolein process. For more detailed information regarding system selection or specifications please contact a Process Insights sales or technical specialist.

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