Measure, Control Moisture in HMA Production

by J. Laffan

With the increasing cost of materials in the production of hot mix asphalt (HMA), producers look closely at ways to reduce costs without affecting quality. Hydronix Ltd., a world leader in microwave moisture measurement, has worked with both the National Center for Asphalt Technology (NCAT), Auburn, Ala., and CETE, the French equivalent, and the results of trials have proved to the experts that moisture control is a cost-effective and practical solution that will both reduce cost and increase quality.

EFFECTS OF VARYING MOISTURE

The gradation of combined aggregates and the properties of the asphalt paving mix are determined largely by the amount of aggregate fed by each cold feed bin to the burner.

Smaller aggregates can absorb more moisture than larger materials (see Figure 1). Rainfall—or increasing moisture—will produce an error in the ratio of combined materials on the cold feed belt. The change in the ratio of materials—by dry weight—causes a change in the density of the asphalt, which affects the finished product. Without moisture compensation, as moisture levels rise, the relative proportion of finer materials will fall, causing a reduction in density.

Figure 1.

Typical moisture ranges for aggregates

Size	Moisture % Range
Fine Sand	2 to 16
Course Sand	2 to 12
1/4	5 to 10
3/8	3 to 4
1/2	2
3/4	1 to 2

Members of the Pennsylvania Department of Transportation (PennDOT) have reported moisture values as high as 7 percent in horizontal recycled asphalt pavement (RAP) stockpiles during the rainy season and now require moisture control for certain material sizes. Although an initial capital cost to the producer, the investment will pay back in a remarkably short period, as is shown later in this article.

The current production practice is to control the ratio of materials by periodic gradation sampling, and to control the burner by measuring the exhaust gas temperature. Both of these are known as feed back control loops. A feed back loop takes data from a point in the process and uses this data to make a correction further back in the process (see Figure 2). This, by definition, is reactive.

The alternative is to use a proactive, real-time or feed forward control system (see Figure 3). By taking real-time moisture measurement of the materials as they leave the stockpile on the cold feed belt, the infor-

Figure 2.

Gradation analysis used as a production tool

A. A drift in composition occurs.

B. Time elapses before next gradation analysis.

C. An error is identified.

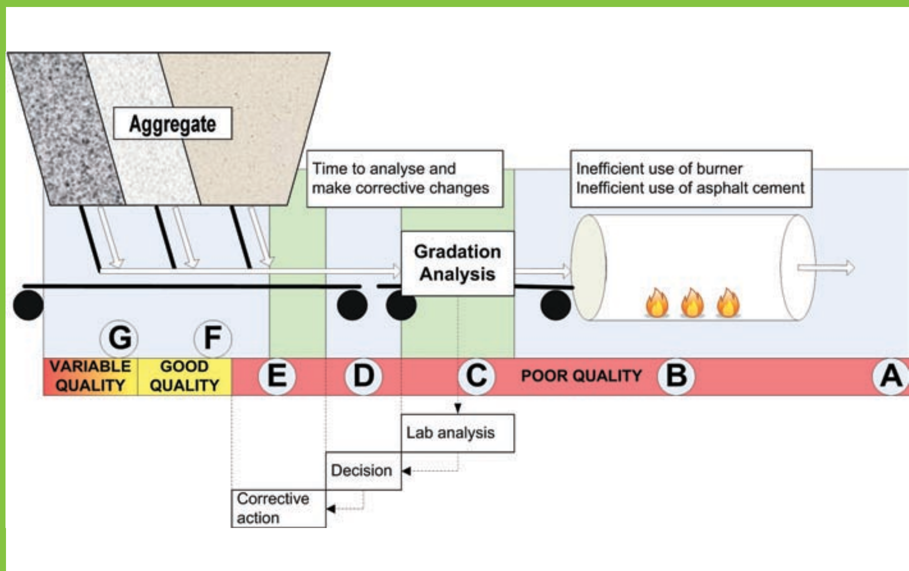
D. Corrective action is decided upon.

E. Manual corrective action is implemented (belt speeds adjusted).

F. Belt speeds are correct (for earlier sample taken at point C).

G. Moisture errors will begin to creep back into the system.

While gradation analysis is a vital part of the quality control process, it's symptomatic in its approach and has limitations as a real-time production control tool.



mation may be fed forward in the process to assist/monitor the burner control. Importantly, this data can be used to adjust the variable speed drives on the cold feed belts to ensure that a consistent ratio of materials is fed to the burner. This maximizes plant output and also ensures a consistent quality of product.

As moisture levels increase, under normal circumstances, this increase should correlate to a reduction in the burner exhaust temperature. However, if more fuel is required to maintain a given temperature and there is no increase in the moisture level of the materials, it may be necessary to service the burner to correct for a loss in efficiency.

INSTALLATION AND CALIBRATION OF A DIGITAL MOISTURE SENSOR

When choosing a moisture sensor, it's important to take into consideration the practicality of physically installing it in the plant, as well as its integration with existing equipment. The most common installation in an asphalt plant is to install two sensors, one on each of the belt feeders for the two finest materials. One of the advantages of the Hydronix Hydro-Probe sensor is in the physical design, which allows a number of installation possibilities (see Figure 4).

A modern sensor should be able to take many moisture readings each second and should be fully compensated against fluctuations in material and ambient temperatures.

Accurately determining moisture content in accordance with AASHTO T255 is not only time consuming, but is also subject to sampling errors, human error, evaporation error and scale error. A reliable moisture sensor, once correctly calibrated, will improve accuracy, reduce human error and should require very little further maintenance, releasing personnel for other tasks.

MOISTURE MEASUREMENT IS A PROVEN TECHNOLOGY

Randy West at NCAT spearheaded a detailed investigation into the latest HMA production technologies. This included examination of industry requirements and new technologies.

NCAT researchers began by asking a panel of industry quality control experts, "What automated measurements appear to be of greatest value and ready for field trials?" The responses were tallied in order of the most frequent. Two of the top four were directly associated to the benefits achievable from using accurate on-line moisture control.

- automated gradation and moisture from the belt sampling
- moisture content on the belts

Others included improved fines control and temperature segregation.

After successful completion of the trials, NCAT researchers reported the results from the Hydronix Hydro-Probe sensor as being +/-0.2 percent moisture, a measurement level exceeding the requirements for control optimization purposes. Their conclusions and recommendations included increased on-line belt sampling of material to identify variances in gradation and also that moisture content compensation must be automated.

THE PAYBACK PERIOD OF MOISTURE MEASUREMENT

An increase of moisture by 1 percent, approximately, requires an additional 0.16 gallons per ton of fuel to evaporate the additional 1 percent

Figure 3.

Real-time moisture measurement and production control

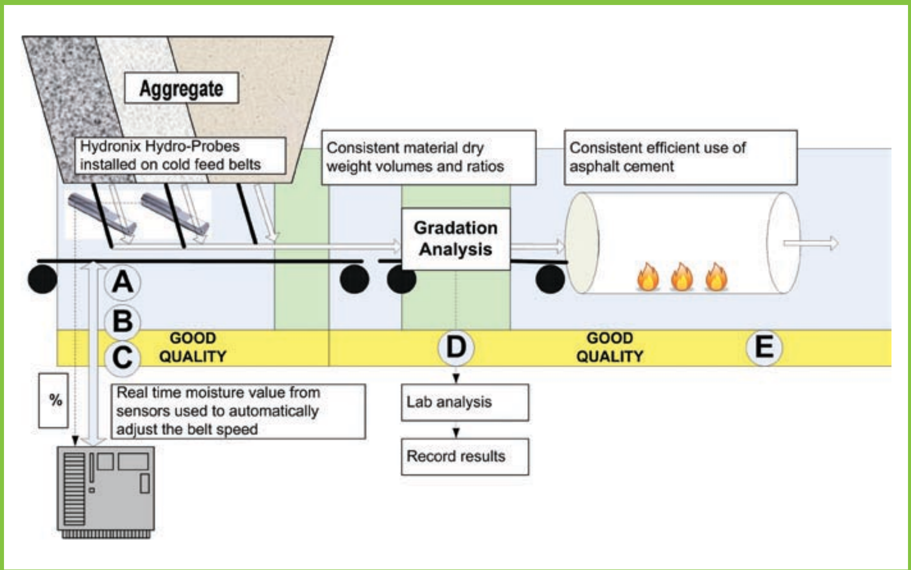
A. Moisture levels are monitored in real time.

B. Adjustment to the speed of the cold feed belts is made immediately.

C. Gradation is consistent.

D. Gradation analysis is performed as part of the quality checking process rather than a production control tool.

E. Asphalt cement is permanently optimized, yields are optimized, quality is consistent, the burners may be monitored for performance.



moisture. Taking the case of PennDOT officials reporting up to 7 percent moisture in the RAP piles during the rainy season, this would equate to 14 tons of water having to be evaporated per hour from a plant producing 200 tons per hour. Without accurate moisture compensation this would also equate to 14 tons of lost yield in comparison to asphalt cement (AC) use and also a reduction in plant output of 14 tons per hour.

As well as the relative increase in the use of AC, there is also the increased cost and environmental issues associated with removal of the excess moisture. The product is also likely to suffer from low density and/or high AC-related quality issues as moisture rises.

Although modern burner control is sophisticated and is certainly adequate for the task, the current preferred method of controlling the burner still remains as a feedback loop. The burner control is dependent upon the exhaust gas temperature. As the moisture level drops, the burner momentarily overheats the material. Reciprocally, as the moisture level rises, the material is momentarily susceptible to being underdried, risking poor adhesion of the binder to the aggregate. Installing moisture measurement ahead of the burner can act as an additional monitor of the performance of the burner as well as the opportunity to feed moisture levels forward to the burner control unit.

Estimating fuel prices at $1.90 per gallon of fuel and with a conservative estimate of an improvement in accuracy of only 0.2 percent moisture, a plant running 200,000 tons per year would save $12,160.00 per annum. This gives a typical, two-sensor installation a return on investment in less than six months.

The effects of moisture are at the heart of various HMA production issues. Accurate moisture measurement and control is proven to give a savings in direct costs as well as ensuring a consistent quality product.

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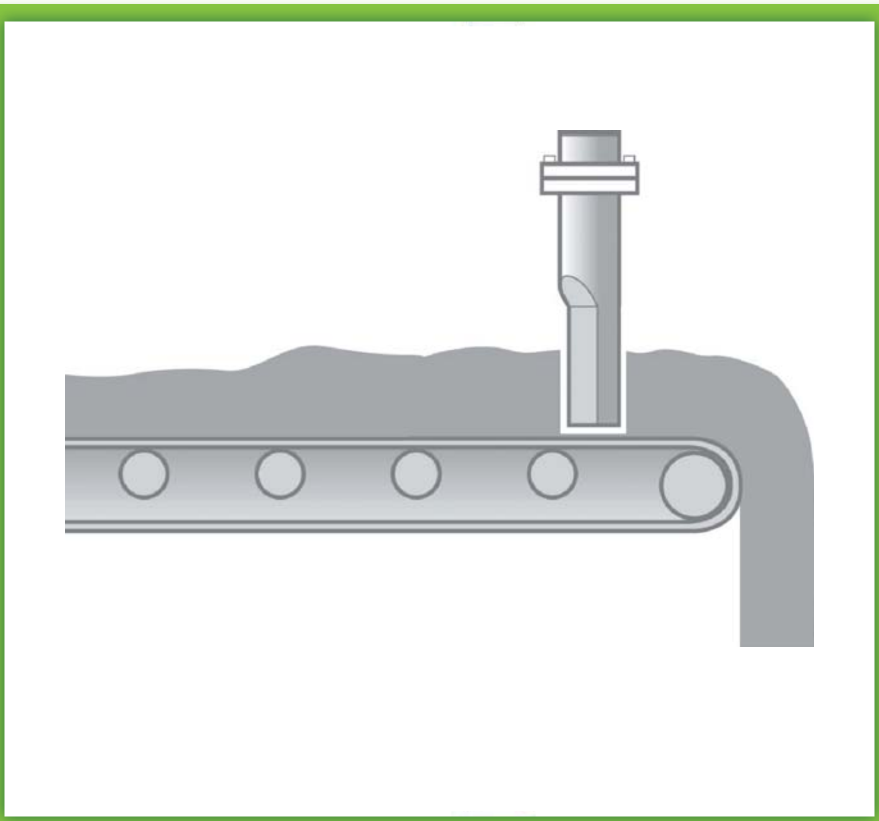

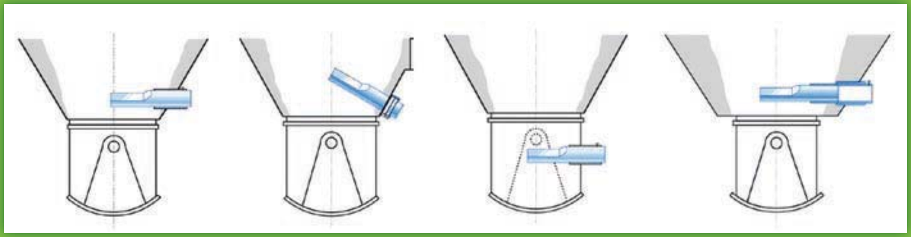

Figure 4.

Installation examples

Installation and calibration is simple. The Hydro-Probe is equipped with its own on-board functionality, calibration software and on-board signal smoothing the high/low moisture alarms. Configuration options allow for various connections to a PC or PLC. The sensor can directly output a moisture percentage value or a linear, unscaled value, that may be calibrated to moisture within an external control system.