SPONSORED RESEARCH

PROJECT TITLE: *Disposable, Wireless Sensor Systems for Integration Within Molds & Cores*

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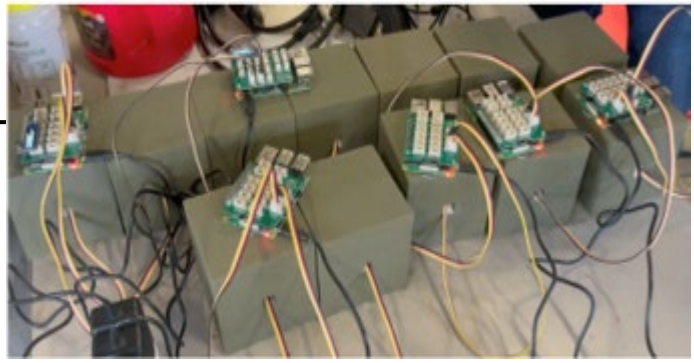
IMPACT: Utilizing low-cost, commercially available sensors to monitor the curing process of 3D printed sand molds to determine the impact of environmental factors on the mechanical properties of the printed molds and cores.

Technical Need

3D printed mold process monitoring in sand and investment casting is virtually nonexistent. Demonstrating viability of using off-the-shelf sensors, to monitor curing process of 3D printed molds, while measuring humidity and VOC's of molds to enable high correlation between quality and yield.



Project Goal

Demonstrate one or more off-the-shelf wireless sensing systems placed within the mold during fabrication to collect humidity, temperature, and VOC data in an effort to define a curing profile.

Technical Approach

Sand blocks were printed, with two wireless sensors inserted midway through printing. Three different environmental conditions were tested in comparison to foundry settings during different times of year: ambient environment (spring), an oven environment set at 35°C (summer) and refrigerated environment (winter). Data was collected for a total of 28 days to ensure the molds were fully cured.

Findings and Conclusions

The present experiment has demonstrated the basic utility of monitoring environmental conditions of printed sand molds and cores to ensure that binder was sufficiently cured. This technique will be further explored to establish guidelines for a window in time for which the molds could be used for casting depending on humidity and temperature. The important conclusion points include:

- Sensors can be embedded successfully within molds during a printer interruption of sand molds to inform the extent of curing.
- For the specific BME680 sensor, the Volatile Organic Compound sensor mode would require calibration to be used in determining if sand binder had sufficiently cured to provide the mold strength required for metal pouring.
- A combined metric of temperature and humidity has been preliminarily shown to provide a higher correlation between the calculated metric and the final mold flexural strength,
- With further experiments, guidelines could be established to allow for the monitoring of temperature and humidity in a mold storage facility to calculate a minimum curing time for any specific conditions.
- Long-duration experiments will be the focus of future work to understand how long 3D printed sand molds remain sufficiently strong, and if these molds need to have an expiration date with the specific consideration of the environmental conditions that the molds were subjected to in the storage facility over time.

AFS Research Project 19-20#12	AFS Transaction 23-082