CENTRALIZED SPRAY SYSTEMS FOR THE PRECASTER

By Robert F. Waterloo

Remember that last batch of thick, steaming pancakes you had for breakfast? Odds have it that you poured some slow-moving syrup on top, and the syrup instantly became more fluid and runny as it hit the hot surface of the pancakes. You were witnessing a change in the syrup’s viscosity, and yes, there is an important message in it for precasters.

So what happened to the syrup? As its temperature increased, its dynamic viscosity decreased, meaning less energy was required to make it flow. Now think of your form release agent. Just like the syrup, the colder the release agent, the thicker or more viscous it will be, and it requires more energy (pressure) to effectively cover a form using your spraying equipment. On the contrary, the warmer your release agent, the thinner it will be, and it requires less energy, or pressure, to cover a form.

The Hill & Griffith Co. recently completed preliminary research on the effects of temperature, spray pressure and orifice sizes with respect to the proper application of release agent for precast concrete products. The results of the research are presented here to assist precast concrete producers in the design of their own spray systems.

Thinner is better

Precast concrete is often specified because of its superior surface quality. A thin application of the proper form release agent is all that is required to easily demold a bug hole-free product. However, it should be noted that a generous helping of form release agent is not the only culprit of bug holes - aggregate gradation, increased fine aggregate contents, decreased placement rates, low workability mixes and improper vibration have all been linked to the formation of bug holes on a product’s surface.

Generally speaking, overapplication of form release agents is a universal problem with precasters. Architectural, prestressed and structural concrete producers should consider the effects of temperature, spray pressure and orifice sizes on the proper application of release agent for their specific projects.
necessitating constant agitation. It is also important to consider any buildup on the form due to the release agent being used. In all cases, cleaning the forms with anything more than a putty knife or ice scraper can cause damage to the form, requiring it to be reseasoned before the next pour, ultimately affecting the production schedule.

**Pressurized systems**
Many precast plants are converting their spraying operations to small, portable pressurized tanks or to more sophisticated centralized systems that supply multiple spraying stations.

**Portable pressurized spray tanks.** Normally, these tanks are pressurized with plant air, resulting in an initial tip pressure of around 100 psi. Initial spraying with 100 psi pressure will generally result in excessive airborne particulate. This is potentially detrimental to employees’ health and is also a waste of form release agent. Over a period of time, there will also be a coating of form release throughout the plant. Another result is that as the tank is drained without repressurizing it, the pressure in the tank continues to drop until a stream of form release (instead of a mist) is applied to the form, resulting in overapplication.

**Power-driven portable spray tanks.** A second type of portable pressurized tank system includes a battery/electrical or gas-driven pump that maintains a constant pressure. Unless the orifice spray pressure is controlled, this type of spray system will also develop higher pressures resulting in considerable airborne form release, causing it to settle on surrounding areas.

**Centralized systems.** The centralized system, while more costly, can afford the precaster the opportunity to control outbound pressure and also allow for easy nozzle changes. Depending on viscosity changes (typically due to ambient temperatures) of the form release, pressure changes and different nozzles will give a fine spray resulting in a thin application. Again, training is important so that employees understand the ramifications of overapplication.

It is also helpful to have an in-line filter, no matter what type of system is used, to remove any impurities that may get into the system.

Three form release agents were used recently in testing. One was a vegetable oil-based material, (EPA-VOC compliant and biodegradable); the second a blend of vegetable oils and a petroleum solvent (EPA-VOC compliant and biodegradable); the third a petroleum-based solvent (EPA-VOC compliant). All are considered “reactive” form release agents. The two materials that are biodegradable meet the Environmental Protection Agency’s and Federal Trade Commission’s recent definitions to be considered “biodegradable.”
Generally speaking, overapplication of form release agents is a universal problem with precasters. Architectural, prestressed (especially when subject to state DOT standards) and burial vault producers usually do the best job since the form release material is typically sprayed on and then wiped with rags or mops to remove the excess release agent. In the past, low-temperature flash point (low-viscosity) form release agents could help alleviate the problem of overapplication. A material with a low flash point would allow the carrying agent to evaporate, resulting in a thinner residue of the remaining carrying agent and the reactive portion. However, most precasters are now going in the other direction due to flammability and other employee safety/health issues and the new EPA VOC (Environmental Protection Agency Volatile Organic Compound) requirements for concrete form release agents.

The majority of concrete form release agents being sold to the precast industry are petroleum-based and, as expected, there are numerous formulations of petroleum-based release agents. Prior to the EPA VOC regulations put into effect in September 1999, many of these form release materials were virtually identical and were classified as "barrier" release agents, i.e., nonreactive (barrier release agents provide a physical barrier between the form and the concrete). With changes in industry demands, EPA VOC requirements, safety/health issues and improved technology, today's precaster has a variety of release agents available. This includes a great number of variable "reactive" components yielding better release due to the formation of metallic soap interface (saponification activity between the "reactive" material and free lime on the surface of the concrete) that forms on the casting surface between the casting and the form.

Application is primarily dependent on three aspects: viscosity of the form release agent (which generally changes with temperature variations), line pressure and nozzle orifice size. As far as the plant personnel aspect, many employees believe that more is better. Employee education is an important and continual process in most precast operations. Employees - especially those applying the form release - often find it difficult to understand that "thinner is better" and that as little as 0.001 inch of release agent is all that is needed to have good release and improved surface finish.

In the past, hand-pump spray tanks were the most popular method of applying form release agents. With the change from diesel-, fuel oil- and kerosene-based release agents, industry suppliers have turned to alternative carrying agents such as highly refined petroleum oils, vegetable oils and water-based carrying agents. These "new" carrying agents usually have the advantage of being VOC compliant, but they will generally have greater variances in viscosity due to temperature changes. Water-based release agents are subject to separation,
Graph 1 shows viscosity changes due to temperature variations of the three materials used in these tests. The term cPs is centiPoise, which is 1/100 of a Poise, a measurement of viscosity.

Graph 1

VISCOSITY VS. TEMPERATURE

Graph 2 shows temperature changes (vertical lines) and nozzle tip pressure (horizontal lines) resulting in a fine spray for thin application. The spray nozzle orifice sizes are shown on the table and are based on variances in temperature and resulting viscosities in the release agents. Changes in the nozzle orifice size are also shown. As these variances can change on a daily basis, there is still some "art" in spraying and is not a 100 percent pure science.

Graph 2

COMPARISON OF SPRAY CHARACTERISTICS RELEASE AGENTS
A flat spray with a spray angle of between 80 degrees and 120 degrees was used in testing.

At warmer temperatures, petroleum-based and petroleum/vegetable oil-based blends require less pressure than do 100 percent vegetable oil blends of release agents. As viscosity increases, air pressure at the orifice tip is increased and nozzle orifice sizing is reduced. From Graph 2, simple conversions of spray tip sizing and orifice pressures are all that are needed to achieve optimum spray application.

Viscosity also affects the thickness of the application of the form release that ultimately ends up on the form. Understandably, the higher the viscosity of the form release, the greater the thickness required to cover the entire surface. A lower viscosity release agent will result in a thinner film thickness. Thinner thickness (lower viscosity) will also result in less material being used to achieve the desired final release and improved surface finish. Again, spraying techniques will affect the final usage and application on the forms.

Portable pressurized spray systems are convenient as they are generally portable, but are subject to the same considerations as a centralized system when it comes to viscosity changes and nozzle orifice pressure. However, centralized systems are becoming more and more popular, due not only to cost considerations of the system, but also to controls in the spraying application. The following information is base on a centralized system.

In-line pressure, in this case, can use plant air, which typically runs between 90 and 110 psi. This high pressure continues through the transport line to each spraying station, but the outbound (spray tip orifice) pressure is regulated to supply the desired pressure. In many cases, a maximum pressure of 30 to 40 psi is desired to minimize airborne particulate, and different nozzle sizes are available to the applicator in order to achieve a thin application of the form release.

Tests were performed to generate data to make recommendations on spray equipment and nozzles. A drum pump, which consists of an air diaphragm pump and drum mounting assembly, was used for testing along with various spray tips.

An extended line was run with a pressure gauge at the end of the line. A liquid pressure regulator, with another pressure gauge, was set at each spray line port. The key is to be able to adjust the liquid pressure (at the spray line port) to optimize the spray nozzle. Be sure to note that spray nozzles are rated to a certain pressure and perform best at that pressure. Too small an orifice opening will result in misting. Higher than rated pressures for the spray tips will result in more misting as well as higher application rates.
While it is only one alternative, the air-diaphragm pump can be mounted almost anywhere the user wishes. This includes mounting on the top of a drum or a larger container, such as a 250-330 gallon tote. A “drop hose” can also be utilized for convenience of switching or refilling drums or totes. The pump size will depend on the plant’s needs. Obviously a longer centralized line will require a higher rated pump than would a short centralized line.

A liquid pressure regulator and pressure gauge will be needed for each spray port station. (The spray port pressure regulator is probably the most important part of the system in that it controls the actual application of the form release). The closer the spray port is to the centralized pump, the higher the line pressure will be. In the same sense, the farther away from the centralized pump, the lower the initial pressure at the spray port. A liquid pressure regulator at each spray port will help to ensure constant pressures at each port. The spray tip orifice size will be dependent on the plant’s needs but should be in the range of 0.1 to 0.5 gpm with any desired degree of fan spray pattern. This type of regulator can also be used on portable pressurized systems and battery/electrical or gas-driven portable spray systems.

If we went to this much effort for our syrup dispensers at breakfast, we could be assured that our pancakes would have a consistent, even coating of syrup.