CRESSET CHEMICAL CO.

Concrete Solutions That Go Beyond The Surface.

Release Agents – What are they? How do they work?

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What are Release Agents

Release Agents, form oils, form releasers, demoulding agents or parting agents are interchangeable names for materials that allow you to separate forms from hardened concrete. Though there are no ACI or ASTM specifications that define these terms, common usage does suggest some differences among them. For example, typically "form oils" refer to diesel oils or home heating oils and "release agents" refer to proprietary materials that contain ingredients that chemically combine with cement. "Form releasers" mean any of the above. "Parting agents" and "demoulding agents" are terms used in other parts of the world.

These materials are subject to regulations from the EPA for clean water, clean air, and clean groundwater. Tightening of shipping regulations from DOT, e.g., HM 181, affects the handling of these materials by manufacturers, distributors and contractors.

Types of Release Agents

You only need two categories to effectively classify most release agents: Barrier types and reactive (or chemically active) types.

Barrier types (non-reactive or passive) work by creating a barrier between the form and the fresh concrete. Common examples include diesel oil, home heating oils, paraffin wax, new motor oil, etc. Diesel and home heating oils are common because they are readily available, inexpensive to purchase and they do release. Creating a barrier between the form and the fresh concrete requires such heavy applications of these oils that bugholes and staining often occur. In a relatively short time essentially all diesel oil evaporates that is why it is often necessary to recoat the forms after a few days. It is this evaporation that affects clean air that will be regulated by the proposed National VOC Law. (Reference: 1. http://www.cresset.com/VOC-Summary.htm. 2. National Volatile Organic Compounds Emission Standards for Architectural Coatings, "Federal Register", June 25, 1996, Volume 61, Number 123, pages 32729-32746. 3. http://www.epa.gov/docs/fedrgstr/EPA-AIR/1996/June/Day-25/pr-23458.html. 4. National Volatile Organic Compounds Emission Standards for Architectural Coatings, "Federal Register", October 8, 1996, Volume 61, Number 196, pages 52735-52736. 5. http://www.epa.gov/docs/fedrgstr/EPA-AIR/1996/October/Day-08/pr-23730DIR/pr-23730.html.)

Chemically active release agents include a wide variety of proprietary materials. Chemically active means that an active ingredient in the release agent chemically combines with calcium (lime) in the fresh cement paste. Typically, the active ingredient (chemically active part) of a release agent is some type of fatty acid. It is frequently dissolved in a carrier, normally a petroleum oil. Properly formulated and applied, this type produces fewer bug-holes, stains and surface irregularities than the barrier types. Also, depending on the brand, they can remain on the form for weeks without a reapplication.

Fatty acids, even when chemically combined with other materials, whether in water based products or oil based products, still prefer to react with the calcium in the cement paste. This calcium/fatty acid product (grease or metallic soap) is very stable and causes the form to release from the concrete.

Admittedly, used crankcase oil works surprisingly well...possibly because of the acids formed during the use of the oil in an engine. When used as a form oil the acids behave similarly to fatty acids, making it both a reactive and a barrier type form oil. There are some drawbacks. In some instances the EPA has required a few concrete operators to clean up yards that contain spilled used motor oil. It is a known carcinogen. Staining and bugholes concern people trying to make architectural concrete.

Applying Less

Most barrier type form oils release better when heavily applied to the form. However, heavy applications of form oil increase chances for staining and bugholes. This oil has to go somewhere and it beads up and goes into the fresh cement paste. It beads up because it is not compatible with the water... it is similar to water beading on a freshly waxed car hood. Using more oil than is necessary is more costly than most people realize. It also increases owners' concerns from EPA regulations. (Ultimately, the owner is responsible for any environmental cleanup.)

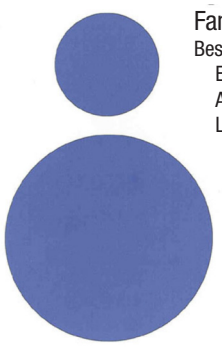
Applying good chemical active release agents in an ultra thin film (say, 0.0005 inches thick), results in many beneficial properties. Benefits include easy removal of forms, clean forms, nearly no bugholes, stains or dusting, and a significant savings in your cost of release agent.

Many people use seven times more (by volume) of diesel type form oil. Over applying release agents dramatically increase your costs. For example, a very high quality release agent may cost $6.00 per gallon. But when properly applied in a thin film it is still cheaper per square foot than a diesel oil form release agent costing only $3.00 per gallon. Typically if a job takes 70 gallons of a $3.00 release agent/form oil the job cost is $210.00. That same job needs only 10 gallons of a good $6.00 release agent for a job cost of $60.00...you save $150.00, reduce environmental exposure and get good-looking concrete to boot.

Applying less to avoid environmental exposure and promote quality requires some attention to good spraying techniques. Use these guidelines to help you achieve economic and performance advantages for spraying thin films of release agents.

Flat Spray Tips: Use flat spray tips. They make very small droplets which help you produce thin films (less material) and better looking concrete. Hollow cone tips produce droplets about 40% larger. Full cone tips (the most common type) produce droplets about 300% larger than flat spray tips. (Differences in droplet size from the different tips results from physics involved in tip design, not the fluids used.)

Figure 1: Relative Droplet Sizes - Magnified 30 Times



A practical release agent pump-up sprayer uses an 8001 flat spray tip which provides droplets fine enough to produce regular or even architectural concrete. An 800067 flat spray tip achieves even finer droplets and potentially better looking concrete. This last tip produces droplets so fine that a light wind blows away the release agent before it falls on the form. Consequently, use this spray tip in environments protected from breezes.

Figure 2 - Flat spray, cone spray picture

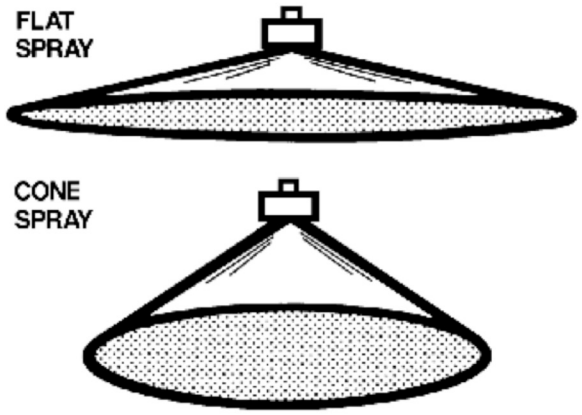
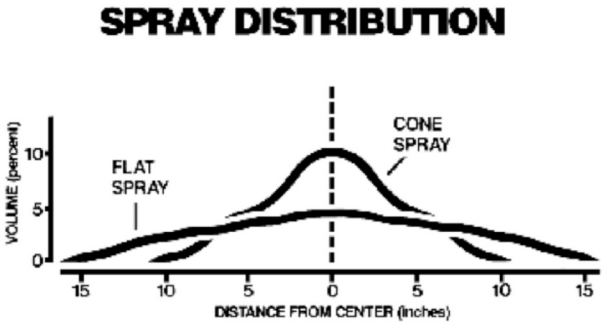


Figure 3 - Spray Distribution Picture



Identifying tips: For an 8001 spray tip the first two digits represent the spray angle, for example 80 degrees. The last digits represent the flow of water through the tip at 40 psi. For example, the 8001 and 800067 tips have a flow rate of 0.10 and 0.067 gallons per minute respectively. The LP80015 flat spray tip is for thicker (water based) release agents...the "LP" stands for low pressure. (Flow rates for low pressure tips are determined at 1/2 the pressure for other tips ... 20 psi.)

Pressure: Spray pressure also affects spray quality. Though a higher pressure produces smaller droplets, a benefit, it also increases the volume flowing through the tip, a negative. At pressures between 30 and 60 psi the volume flowing through the 8001 flat spray tip is sufficient. Therefore, a higher pressure does not necessarily help you reduce release agent film thicknesses nor does it necessarily mean better looking concrete. Pressures between 30 and 60 psi produce a uniformly thin film across the full width of the spray pattern (See "Flat Spray" Figure 3.) Below 30 psi the spray pattern is not uniform and the average droplet size increases...making it difficult to produce good looking concrete. Typically a good manual pump-up sprayer produces about 35 psi...if you lean hard on the pump.

Temperature: Temperature has little effect on factors controlling the spraying process. However, low winter temperatures increase the viscosity (thickness) of oil ruining the spray pattern. Using premium carrier oils that don't thicken much until temperatures drop below about 15°F helps solve this problem. For release agents made with these premium oils, increasing the spray pressure by 5 psi or so overcomes any spraying problems caused by thickening.

With less sophisticated release agents and when temperatures fall below about 40°F many release agents thicken. To overcome thickening, a thinner ("Winterizer") is often added. A few "Winterizers" contain extra active ingredients (fatty acids) to help assure a good, clean chemical release. Otherwise, straight diesel oil is most commonly used to thin release agents... but the lack of active ingredients may contribute to sticking, staining, bugholes, etc. All winterizers contribute to an adverse change in VOC. A 5 gallon pail of thinner added to a drum is enough to make most release agents exceed VOC limits...creating an environmental concern.

Hazardous Materials

Release agents/form oils containing more than about 25% diesel or home heating oils will not pass EPA regulations governing VOC (Volatile Organic Compounds) in states enforcing the Clean Air Act. Since November 1993, new Department of Transportation (DOT) shipping regulations redefine hazardous materials for transportation purposes. These regulations are similar to, but not identical with definitions of hazardous materials by the Environmental Protection Agency (EPA) and OSHA.

EPA, DOT, and OSHA agree that flammable materials have a flash point below 141°F. However, for purposes of domestic ground transportation only, the DOT further defines materials as "combustible" if they have a flash point between 100°F and 200°F. The flash point issue is further complicated by UN and DOT regulations for air and ocean transportation, where flammable applies to materials with a flash point below 140°F and UN regulations do not recognize "combustible" materials as hazardous. Products made with diesel oil, kerosene, mineral spirits and some other common solvents fall into this confusing flash point range.

Transportation regulations are an area of environmental and OSHA concern for release agents, curing compounds, sealers, waterproofing materials and coatings.

The situation is this: (a) The DOT says that if the flash point is between 100°F and 200°F the materials are considered hazardous (Combustible) only if they are in a package of 119 gallons or larger. This only includes "Tote Tanks", "MegaPaks", tanks and bulk.

(b) When packaged in any container size and when the flash point is between 100°F and 140°F, the materials are hazardous (flammable) for OSHA and EPA regulations. Even so if the flash point is between 100°F and 140°F, federal DOT regulations sometimes do not require the DOT flammable placards or labels on containers smaller than 119 gallons...for domestic ground transportation only.

(c) Anything below a flash point of 100°F is always flammable by all agencies and there are three flammable DOT hazard classes.

(d) Flash points are only one of several criteria for defining hazardous materials.

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Summary
Releasing is easy...better release agents have additional manufactured-in properties including:

- sprayable at temperatures below 20°F...for projects lasting more than one season
- not evaporating off the form at ambient temperatures near and above 100°F
- non-staining even when using heat on the forms
- complying with OSHA and EPA regulations
- reducing imperfections (bugholes) in concrete
- usable even after being on the form for two weeks
- helping you produce good-looking concrete surfaces
- the product does not gel or get real thick in galvanized sprayers.
- a flash point above 141°F or better yet, over 200°F, to avoid hazardous OSHA shipping and disposal problems
- not getting real thick and/or not settling out at cold temperatures (try putting your release agent/form oil in the freezer for a couple of hours)
- low odor
- not interfering with subsequent adhesion of surface coating treatments or sealers to the hardened concrete
- non-dusting
- compatible with admixtures
- water-based release agents that wet (make a continuous film) on a used oily form...most water based products bead on oily surfaces

Use less release agent...you save money, you CYA (Cover Your Assets) with the EPA and your concrete looks a lot better.

Appendices
A. How Release Agents work

Appendix A

How Release Agents Work
You need fatty acids to make a good chemically active type release agent. Fatty acids are derived from fat, from which they get their name. They come from a variety of natural sources...all living things, e.g., soybeans, flaxseed, trees, hogs, cattle, fish, etc. (Fatty acids are what you want to get rid of when you go on a diet.) They are very, very weak organic acids much different from strong mineral acids like sulfuric acid or muriatic acid. Interestingly, fatty acids contain an even number of carbon atoms...most notably 18. Manufacturers use them to make release agents, soaps, lubricants, cutting oils, cosmetics... the list goes on and on.

Some fatty acids in release agents are unsaturated, similar to the unsaturated vegetable oils in margarine and cooking oils. Vegetable oils (fatty acids) and petroleum oils are not chemically similar and good technical literature will distinguish between them. In poorly formulated release agents fatty acids end up, unused, on the bottom of the container, especially when temperatures drop below 50°F. Test yours in a refrigerator or freezer.

Producing a successful product for use over a wide temperature range requires a chemical trick to keep the fatty acids off the bottom of the container and in the carrier. Most commonly, manufacturers simply react the fatty acid with another material. (Other manufacturers simply use the natural vegetable or animal oils which are already reacted with another chemical.) Whichever approach is used, the modified fatty acid has better low temperature stability (does not settle to the bottom) and sometimes better form wetting ability.

(Please note that the chemically reactive materials in cement are ions, especially calcium ions. Concrete technologists shorten this to calcium, which confuses chemists and any chemistry student reading this. However, we use the “calcium” convention in this article.)

Though the fatty acid now has another chemical group attached to it the affinity for calcium (from the cement paste) is stronger than the desire for the other chemical group. Consequently, calcium dislodges the other material and attaches to the fatty acid at the same spot where the other material was attached. Chemists call the calcium-fatty acid product a grease or metallic soap or salt. It is greasy...chemically identical to the old fashioned bath tub ring. This slippery, greasy, non-water soluble soap is the chemical that allows you to release your forms from hardened concrete. This reaction with calcium gives rise to the term “chemically active release agent”.

This reaction at the surface of the form/concrete interface is complex and critical for deciding the final appearance of the concrete. The type of fatty acid, the ambient temperature and the chemical nature of the attached group (if any) determine the wetting properties of the release agent and the speed of the calcium-fatty acid reaction. These chemical characteristics combined with the carrier oil (or water) from the release agent, helps determine the final appearance of the concrete, including color. Selecting the correct ingredients for producing a release agent that balances concrete surface, appearance, clean forms, environmental and OSHA considerations, and exceptional performance over a wide temperature range is difficult.

Because of the hundreds of possible combinations of ingredients, no two proprietary release agents produce the same concrete surface color and texture. Releasing is the easy part, now the manufacturer needs to select ingredients to CYA with the EPA and OSHA. And to provide a product that helps you produce very good-looking concrete under a variety of working conditions.