




Precast Form Release Agents: Problems & Solutions

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Course Description

Concrete form release agents are often overlooked when designing and specifying concrete structures. In addition, many wrongly believe that form release agents are all one in the same, but in reality, there are a wide variety of agents with different performance characteristics. Recent innovations in form release technology have introduced more sustainable products to the market, and higher performing release agents that result in more beautiful concrete structures. Do not let form release agents be an afterthought. Specifying the appropriate formula from a reputable manufacturer will help to achieve a concrete building that is as beautiful as envisioned.



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Introduction to Release Agents

- Materials that let you easily separate forms from hardened concrete
- Other names for release agents:
 - Demoulding fluids
 - Debonding agents
 - Dismounting agents
- Proprietary materials that contain ingredients that chemically react with cement
- Chemically active proprietary blends are preferred



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Introduction to Release Agents

- Ease formwork removal
- Extend useful life of a form
- Improve smoothness and texture of concrete
- Release agent manufacturer will help to determine ideal release agent for intended application

<i>Types of Form Liner Materials</i>
Polyurethane
Expanded polyurethane
Polystyrene
Steel
Plywood
Fiberglass
Aluminum
SBR
Natural rubber
Latex

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ACI 347 Section 6.4

“Form release agents are applied to the form contact surfaces to prevent bond and thus facilitate stripping. They may be applied permanently to certain form materials during manufacture, but are normally applied to the form before each use. When applying in the field, be careful to avoid coating adjacent construction joint surfaces or reinforcing steel. When concrete surface color is critical, effects of the coating, sealing, and release agents should be evaluated. Where surface treatments such as paint, tile adhesive, sealers, or other coatings are to be applied to formed concrete surfaces, be sure that adhesion of such surface treatments will not be impaired or prevented by use of the coating, sealers, or release agent. Also, consider bonding requirements of subsequent concrete placements.”

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Release Agents Solve Concrete Challenges



Bugholes



High Cost of
Formwork

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Bugholes

- Also called pinholes, blowholes, and surface voids
- Small, regular, or irregular cavities resulting from entrapment of air bubbles on surface of vertically formed concrete during placement and consolidation
- Primarily an aesthetic concern, but can cause problems upon painting or if voids are larger than 1"
- Note: Form release agents cannot solve bugholes larger than 1" – there is a problem with concrete mix



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Minimizing Bugholes

- Causes of bugholes:
 - Dents, holes, build-up, and roughness in form
 - Form material
 - Excess moisture in forms
 - Excess release agent
 - Mix design
 - Improper vibration and concrete placement
 - Irregular size aggregate



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Minimizing Bugholes

- Causes of bugholes in self-consolidating concrete (SCC):
 - Problems with SCC mix design (cement, water, viscosity, and admixtures)
 - How SCC is placed in the form
 - Improper selection and application of form release agents



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Minimizing Bugholes

- Use SCC or a highly fluid concrete
- Use a vibrator with proper frequency and amplitude
- Use well-graded/clean aggregate
- Use concrete with sufficient paste volume and viscosity
- Minimize drop height of concrete to avoid trapping air
- Place concrete slowly



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How Much Money Do You Save By Buying a Cheap Form Oil?



Pitch dec

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High Cost of Formwork

- Replacing forms often is very expensive and time consuming
- Requires careful planning by engineer/architect and formwork engineer/contractor

"The cost of formwork can be greater than 1/2 the total cost of the concrete structure."
-ACI's Guide to Formwork for Concrete



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High Cost of Formwork

- Maximize how long a form can be used by proper cleaning and use of form release agents
- Save significant labor and material costs

Release agents cost 80% less than the labor for cleaning formwork.

Cleaning labor = \$.10 per sq ft
Release agent = \$.0001 per sq ft



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Types of Release Agents



Barrier
Types



Reactive
Types



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Barrier Types

- Work by creating a barrier between form and fresh concrete
- Require heavy application, resulting in bugholes and staining
- Very hot and cold weather affect form removal
- May prevent coating adhesion
- Not recommended for architectural concrete

Barrier Type Agents

Diesel fuel

Home heating oils

Paraffin wax

New motor oil

Crankcase oil

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Barrier Types

- Cost more per square foot
- Can cause environmental issues
- May not be EPA approved
- Use recycled waste oil, which causes staining and inconsistent quality
- Volatile oils evaporate quickly and must be reapplied often
- VOCs are released



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Chemically Active (Reactive)

- An active ingredient in release agent chemically reacts with calcium (lime) in fresh cement paste
- Chemically active ingredient is typically a fatty acid or modified fatty acid dissolved in a carrier such as petroleum oil
- Fatty acids are naturally produced by humans, animals, and plants



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Chemically Active (Reactive)

- Produce fewer bugholes, stains, and surface irregularities than barrier types
- Commonly used for architectural concrete
- Can remain on form for weeks without reapplication
- Only requires an ultra-thin film (7x less than barrier types)
 - Costs less
 - More environmentally friendly



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How Release Agents Work

- Fatty acids create a slippery, greasy, non-water-soluble soap that allows form to easily release from hardened concrete
- Works over a variety of temps
- Factors that determine final appearance of concrete:
 - Ambient temperature
 - Chemical nature of attached group
 - Wetting properties of release agent
 - Speed of calcium-fatty acid reaction



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How Release Agents Work

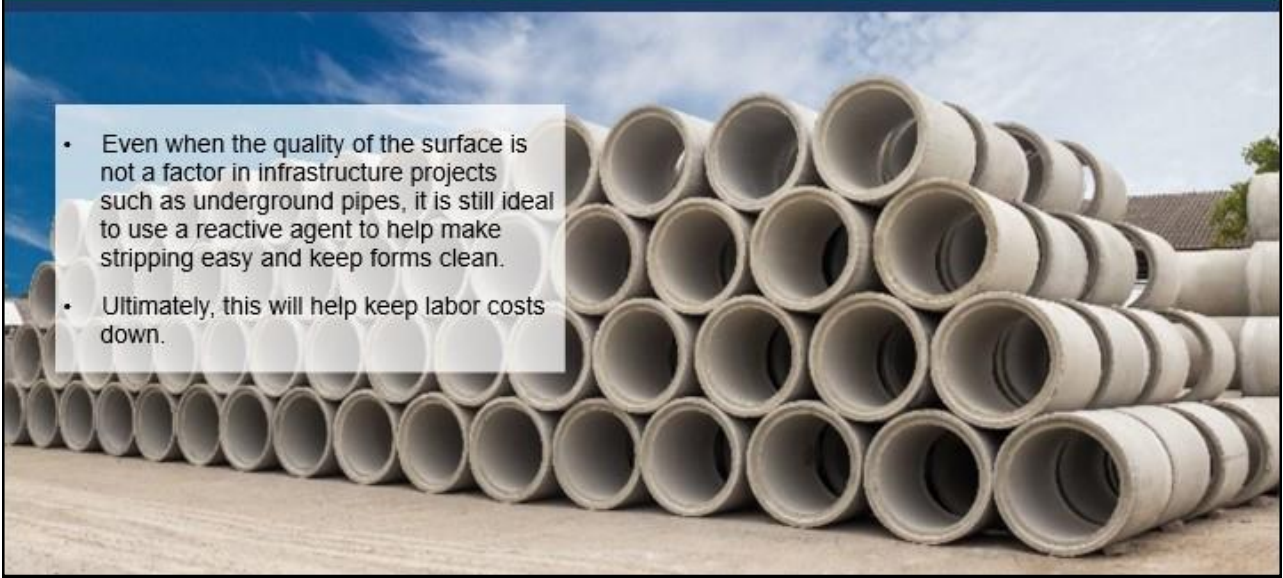
- Release agent must balance:
 - Concrete surface
 - Appearance
 - Clean forms
 - Environmental and OSHA considerations
 - Exceptional performance over a wide temperature range
- No two proprietary release agents produce same concrete surface color and texture
- Consult with manufacturer to specify proper formulation



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Infrastructure

- Even when the quality of the surface is not a factor in infrastructure projects such as underground pipes, it is still ideal to use a reactive agent to help make stripping easy and keep forms clean.
- Ultimately, this will help keep labor costs down.



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Sustainability

- Release agents subject to:
 - EPA regulations for clean water, air, and groundwater
 - DOT shipping regulations regarding flash points
- USDA Biobased Product Certification required for federally funded construction projects



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Diesel Prohibitions

- Diesel now prohibited because VOC emissions contribute to smog
- Motor oil is a known carcinogen
- Release agents/form oils containing more than 25% diesel or home heating oils will not pass EPA regulations for VOCs in states enforcing Clean Air Act

In the U.S., release agents have to meet federal VOC limits of 450 g/L and may have to meet more restrictive limits of 250 g/L in some states.



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Combustibility

- EPA, DOT, and OSHA agree that flammable materials have a flash point below 141°F
- For domestic transportation DOT defines materials as "combustible" and therefore hazardous with a 100 - 200°F flash point
- UN and DOT regulations for air and ocean transportation are different than ground
- Products made with diesel, kerosene, mineral spirits, and other 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.

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Low-VOC Release Agents

- Non-HazMat, 100% vegetable-based formulations
- No waxes, silicones, or carcinogens
- Solventless
- Non-toxic
- Significantly higher flash points
- Achieve VOCs less than 5 g/L
- Comply with all federal, state, and local regulations requiring VOC ratings less than 450 g/L, 250, g/L, and 100 g/L respectively

Mineral spirits are replaced with proprietary blend of neutralized vegetable oils in a low-VOC, synthetic, non-petroleum oil.



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Low-VOC Release Agents

- Meet ASTM biodegradability rule of reaching their half-life in 28 days
- 100% biodegradable formulations are either:
 - 100% vegetable based (USDA Certified Biobased Product)
 - Vegetable-based cut with mineral oil to reduce cost
- Products can help with LEED certification for low-VOC content



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Other Specialty Form Treatments

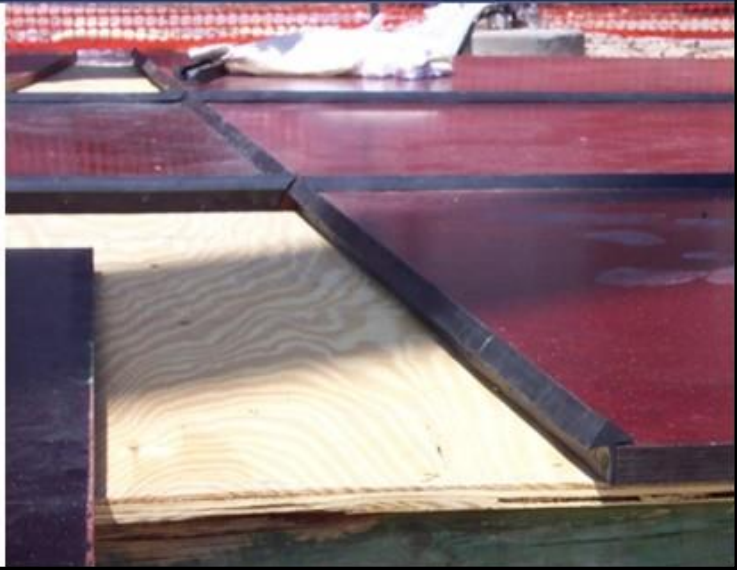
- Accessory treatments can be applied to forms, equipment, and tools to further ease labor and extend life of forms
- Additives incorporated so release agents bond better to forms
 - Improve form removal from sticky mixes



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Rust Preventative

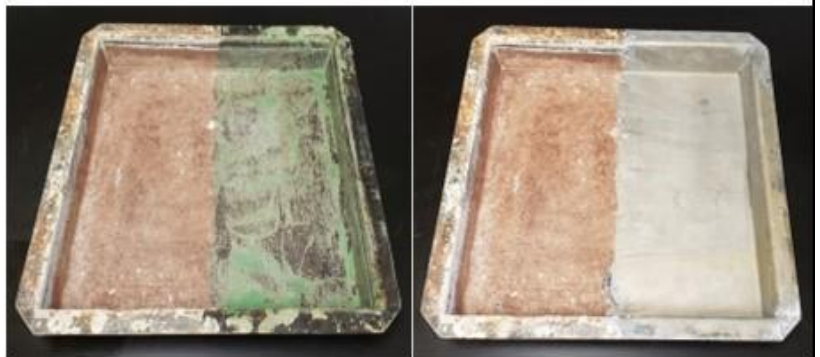
- Applied to steel forms, equipment, and tools to protect from rust and corrosion for up to 6 months
- Creates tight barrier against moisture and vapor
- High quality rust preventatives do not harden or gel, but rather stay oily
- Can be used as a release agent and don't require removal



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Rust Remover

- Water-based, biodegradable, non-flammable product
- Removes rust and concrete buildup on steel forms or equipment
- Quality rust removers:
 - Meet or exceed VOC regulations in all states
 - Safer for skin than inferior products
- Should be used before pouring concrete or painting



BEFORE REMOVAL

AFTER REMOVAL

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Spatter Protection

- Mixture of corrosion inhibitors and non-stick polymers
- Applied to equipment surfaces exposed to spatter
- Allows spattered concrete to wash away easily
- Keeps tools/equipment free from buildup and working
- Saves time, extends product life, prevents malfunctions
- Some are water-based, made of virgin material, and eco-friendly

Can Be Used On

Ready-mix trucks

Highway paving equipment

Portable batch plants

Concrete tools/accessories

Screeds

Back side of forms

Dry-mix mixers

Hard surface furnishings

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Formulation Considerations

- Chemically active vs. barrier
- Freeze damage
- Color (straw, white, light blue)
- Coverage
- Cost per square foot
- Effect on concrete surface
 - Dusting
 - Paintability
 - Non-staining
 - Compatible with admixtures
- Compatibility with formliners



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Flash Point

Materials are flammable when they have a flash point of less than 141° F.

Material	Flash Point
Gasoline	-50°F
Diesel	115-185°F
Low-VOC release agents	>220°F
Water-based materials	No flash point

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VOC of Common Materials

Material	Measurement in g/L
Diesel	860 g/L
Low-VOC release agents	160-245 g/L
Water	NA

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Non-Standardized Tests

- Release agents are often tested by the manufacturer for:
 - Ease of form removal
 - Build-up
 - Dusting
 - Few or no bugholes
 - Color variations



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Field Tests for Goodness

- Cold temperature issues
 - Affect spray pattern and appearance
 - Test in refrigerator in a glass jar or freezer
- Color
 - Cloudiness affects sprayability and quality
- Skin reactivity
 - Wash hands with release agent
 - Check for stinging and odor
- Form layer failure
- Determining whether a release agent will wash off in the rain

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Field Tests for Goodness

- Form liner failure
 - Test durability by immersing form material in jar of release agent for 10 seconds, then 4 hours
 - Check for swelling, softening, or a gooey residue
- Whether release agent washes off in rain
 - Rub 10 drops between fingers in stream of cold running water for 20 seconds

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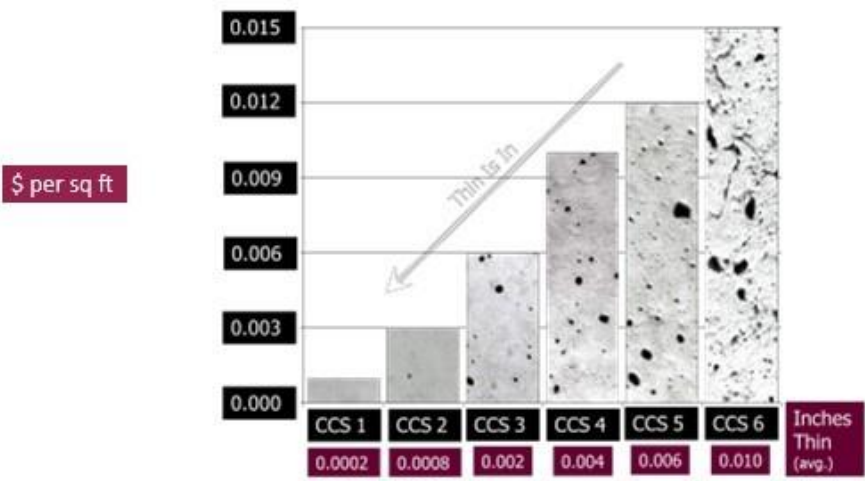
Application Considerations

- Barrier type form oils release better when heavily applied
 - Increases staining and bugholes
 - Costs more
 - Increases environmental concerns
- Chemically active release agents are applied in an ultra-thin film (0.0005" thick)
 - Easy removal of forms
 - Clean forms
 - Minimal bugholes
 - Minimal stains and dusting
 - Cost savings



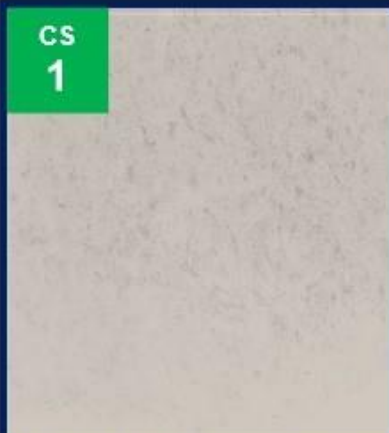


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Application Considerations



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Concrete Standards (CS)

CS 1  Applied Film Thickness <0.0005 inches	CS 2  Applied Film Thickness 0.001 inches	CS 3  Applied Film Thickness 0.002 inches
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Concrete Standards (CS)



**CS
4**

**Applied Film Thickness
0.003 inches**



**CS
5**

**Applied Film Thickness
0.004 inches**



**CS
6**

**Applied Film Thickness
0.005 inches**

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Spray Application Equipment

- Good spraying techniques involve:
 - Spray application equipment
 - Tip types
 - Spray pressure
 - Temperature conditions
- 3 form release agent sprayers:
 - Compressed air
 - Electric sprayer
 - Manual/hand pump sprayer



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Spray Application Equipment

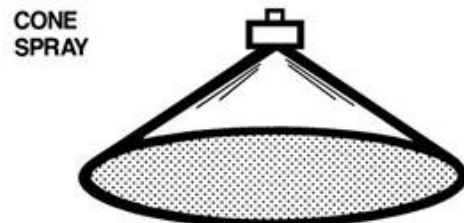
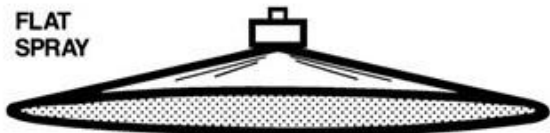
- Compressed air sprayers
 - Best option
 - 25' hose, compressed air tank, and liquid tank
 - Compressed air tank = 200 psi
 - Liquid tank = 125 psi
- Electric sprayer
 - Next best option
 - Adjustable from 40-100 psi
 - Sprays up to 2,000 sq ft/gallon
 - Sprays up to 700 ft from sprayer
- Manual sprayer
 - 2-gallon stainless steel tank
 - 48" hose, 18" brass extension, choice of 3 fan tips



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Tip Types

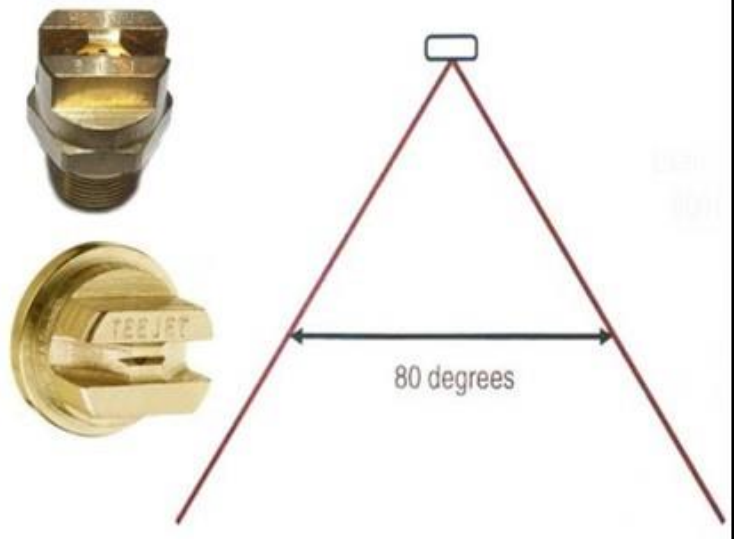
- Sprayer tip parts:
 - Cap
 - Tip
 - Mesh filter
- Tip types:
 - Flat spray tips
 - Creates very small droplets to produce uniformly thin films
 - 30% smaller droplets than cone spray
 - Hollow cone tips
 - 40% larger droplets than flat spray tips
 - Full cone tips
 - 300% larger droplets than flat spray tips



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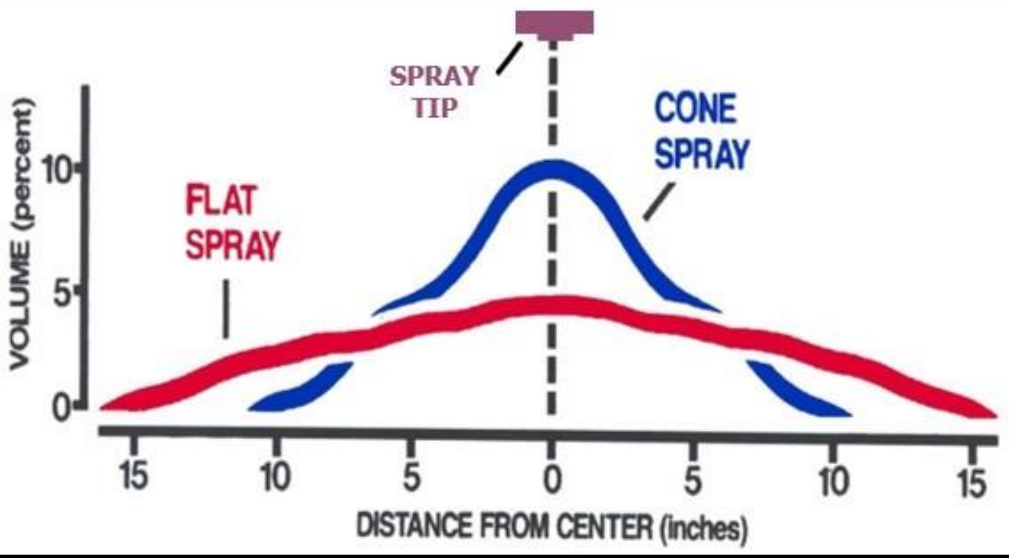
Identifying Tips

- First two digits represent spray angle
- Last digits represent flow of water through tip at 40 psi
- Example: 8001 and 80067 tips both have a spray angle of 80 degrees with a flow rate of 0.10 and 0.067 gallons/minute, respectively



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Spray Pressure



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Temperature Conditions and Winterizers

- Low winter temperatures increase viscosity of oil, potentially ruining spray pattern
- Use premium carrier oils that don't thicken until temperature drops below 15°F
- Winterizers can be added to assure a good, clean chemical release
- Beware that they contribute to higher VOCs, possibly exceeding limits



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Application Steps

Prepare the form



Apply form release



Wipe form surface



Pour concrete



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Application Steps

Consolidate concrete



Cure



Strip forms



Clean forms



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Conclusion

We hope you now have a better understanding of how important concrete release agents are when attempting to accomplish a beautiful, bughole-free, architectural concrete building with high visual impact.

The cost of using release agents is negligible when you consider the time saved cleaning forms and money saved replacing forms.

Form release agents ease formwork removal, extend the useful life of a form, and improve the smoothness and texture of concrete surfaces. They should not be overlooked when designing and specifying concrete structures.



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Questions?



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