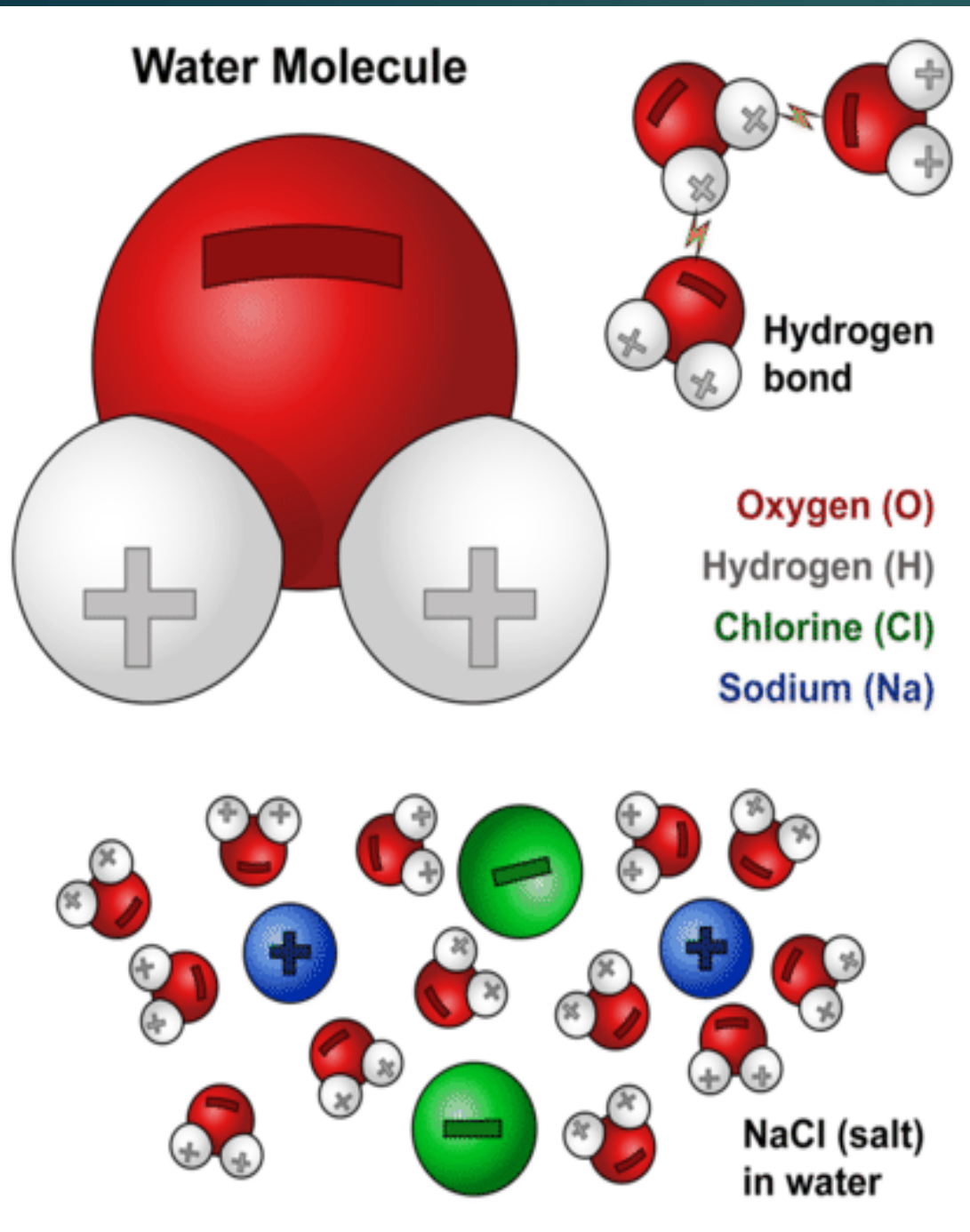




The Science of Salt

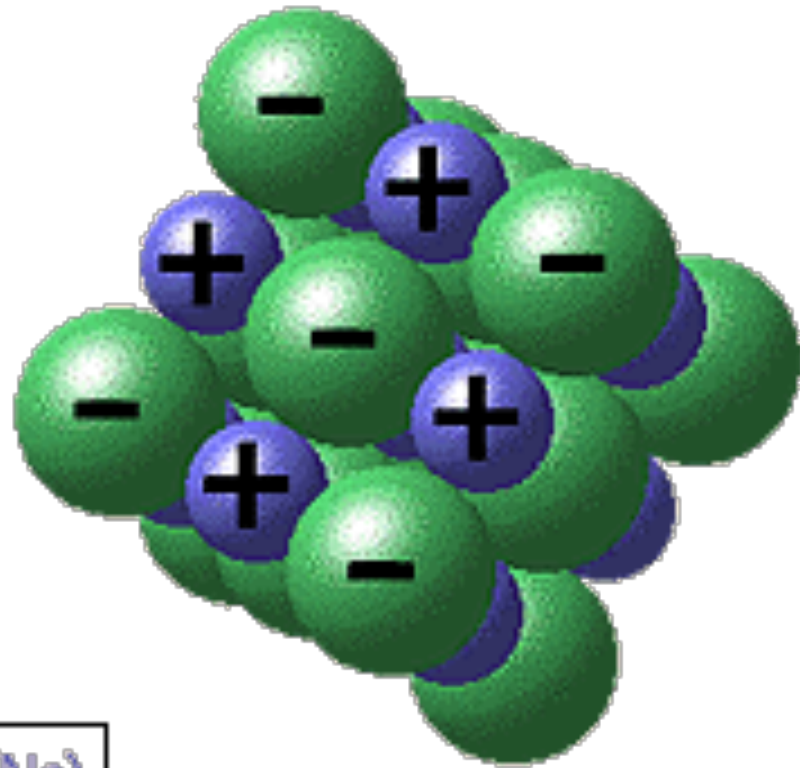
STU JOHNSON

VT LOCAL ROADS BRANCH MANAGER AND MAD CHEMIST



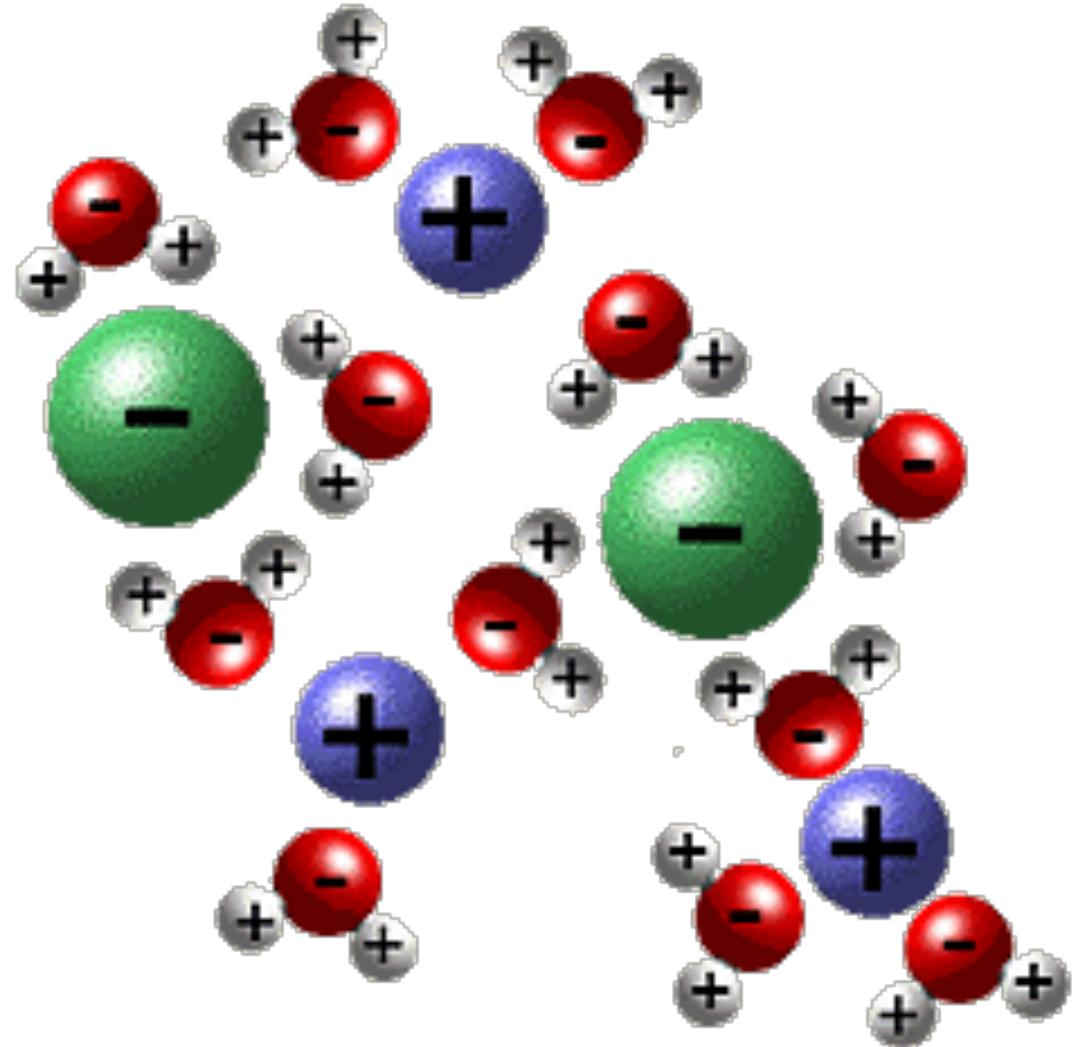
- ▶ Salt (NaCl) and water (H₂O) are compounds with polarity, positive and negative sides
- ▶ Water has a **covalent** bond between two hydrogen atoms(H) and an oxygen (O) atom. (H two O)
- ▶ Salt has an **ionic** bond with one atom each of Chlorine(Cl) and Sodium (Na)
- ▶ Sodium (Na), Calcium (Ca), Magnesium (Mg) all have the same **ionic** bond with Cl
- ▶ The **covalent** bonds are stronger than the **ionic** bonds, pulling the salt molecules apart
- ▶ **Dissolving and making BRINE**


NaCl crystal structure



sodium (Na)
chlorine (Cl)

NaCl in water

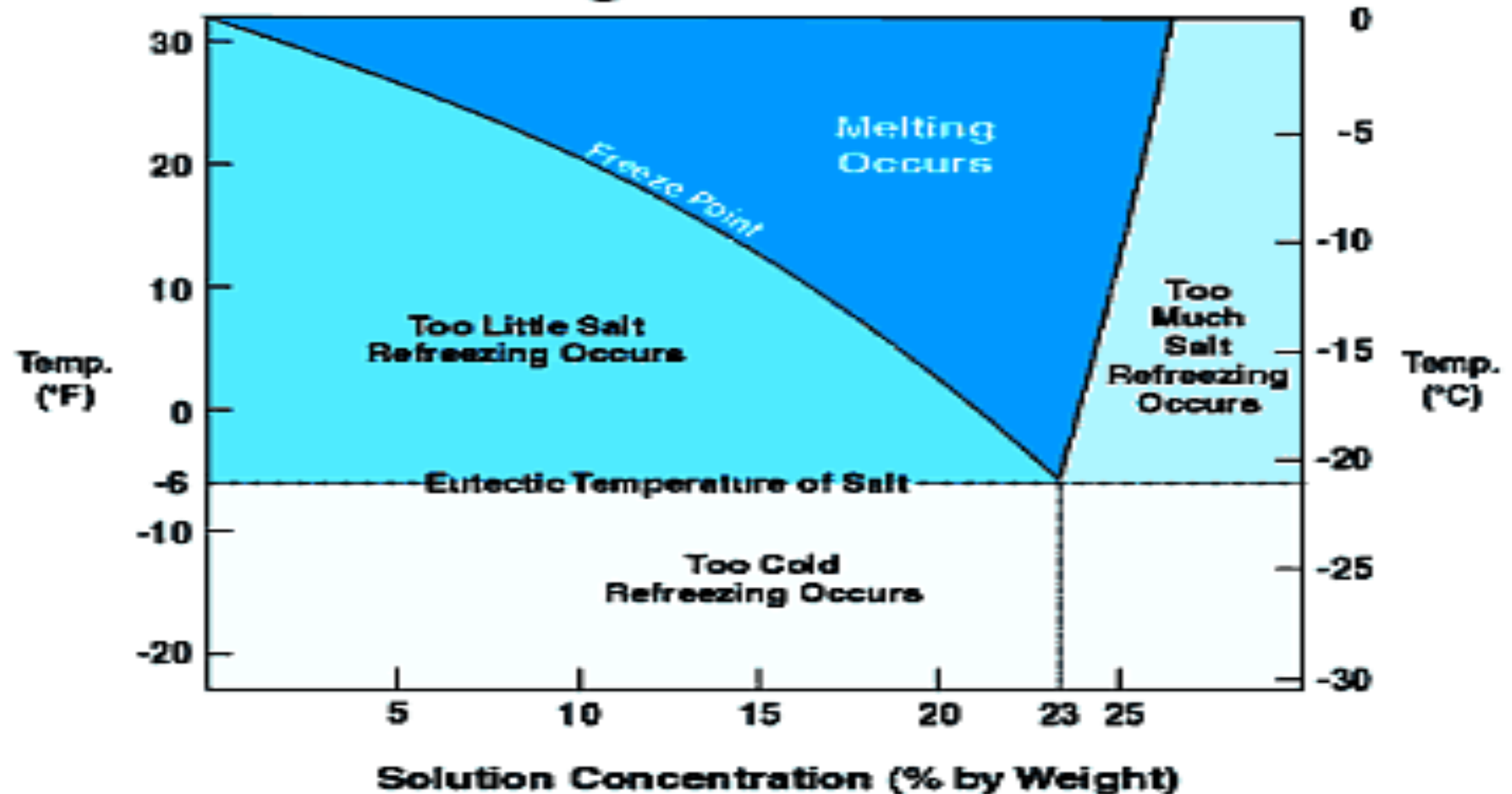


- 
- ▶ Contrary to conventional wisdom, this process, dissolving salt, does not create heat that melts frozen water. (that would be an **exothermic** reaction, giving off heat)
 - ▶ It actually requires, or absorbs heat, just enough to be called an **endothermic** reaction.
 - ▶ The dissolving salt creates a brine that has a lower freeze-point than water, so it stays liquid....UNTIL it reaches its freeze point. As it dilutes the freeze point rises

The **Freeze-point** is determined by the concentration of the brine


The **Eutectic** temperature is the lowest temperature before a compound will freeze

Phase Diagram for Salt



So, what is the Optimal
concentration when
making brine?????

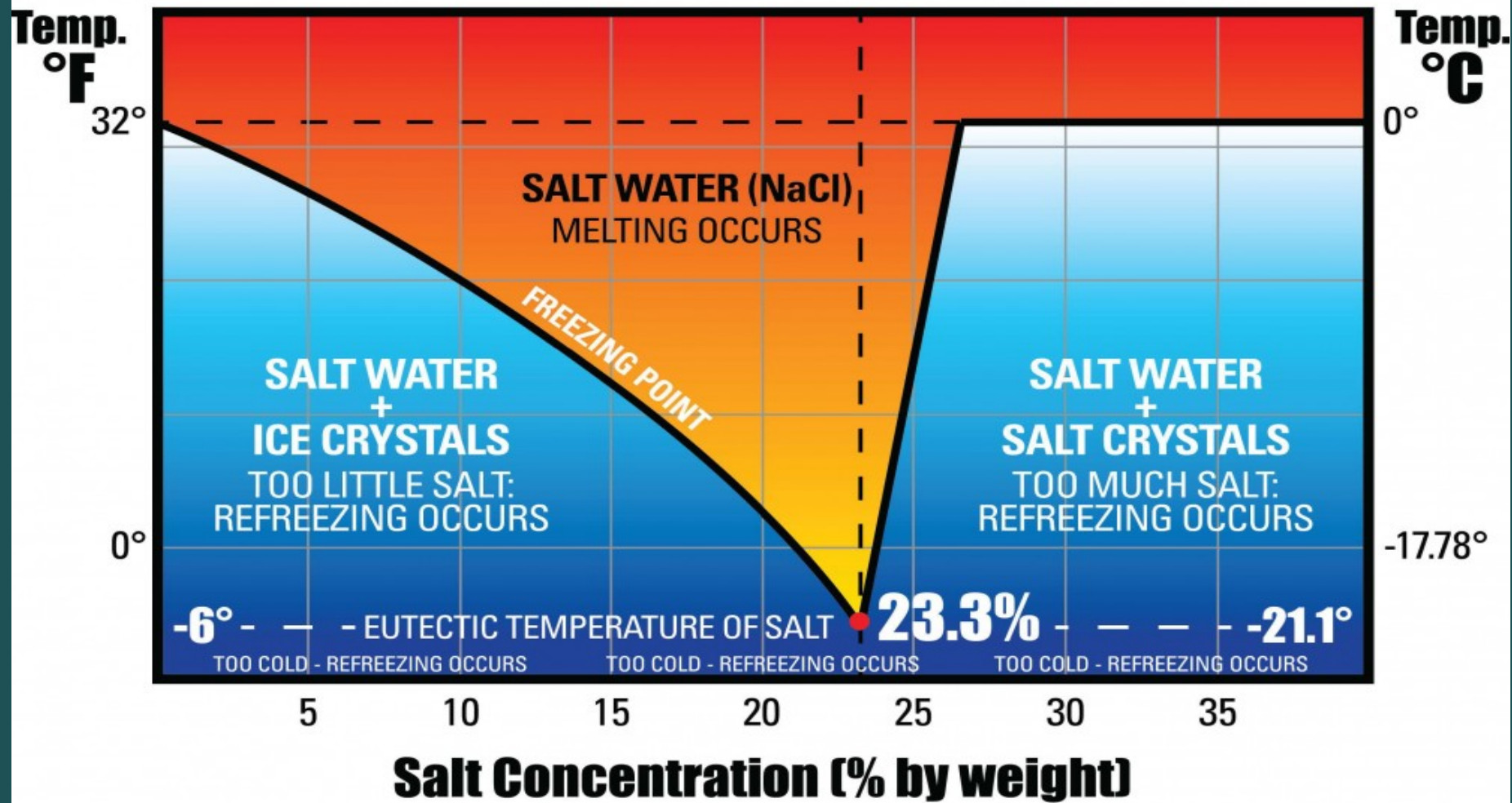
23%, actually 23.3 %



Which will give us a Eutectic temperature of?

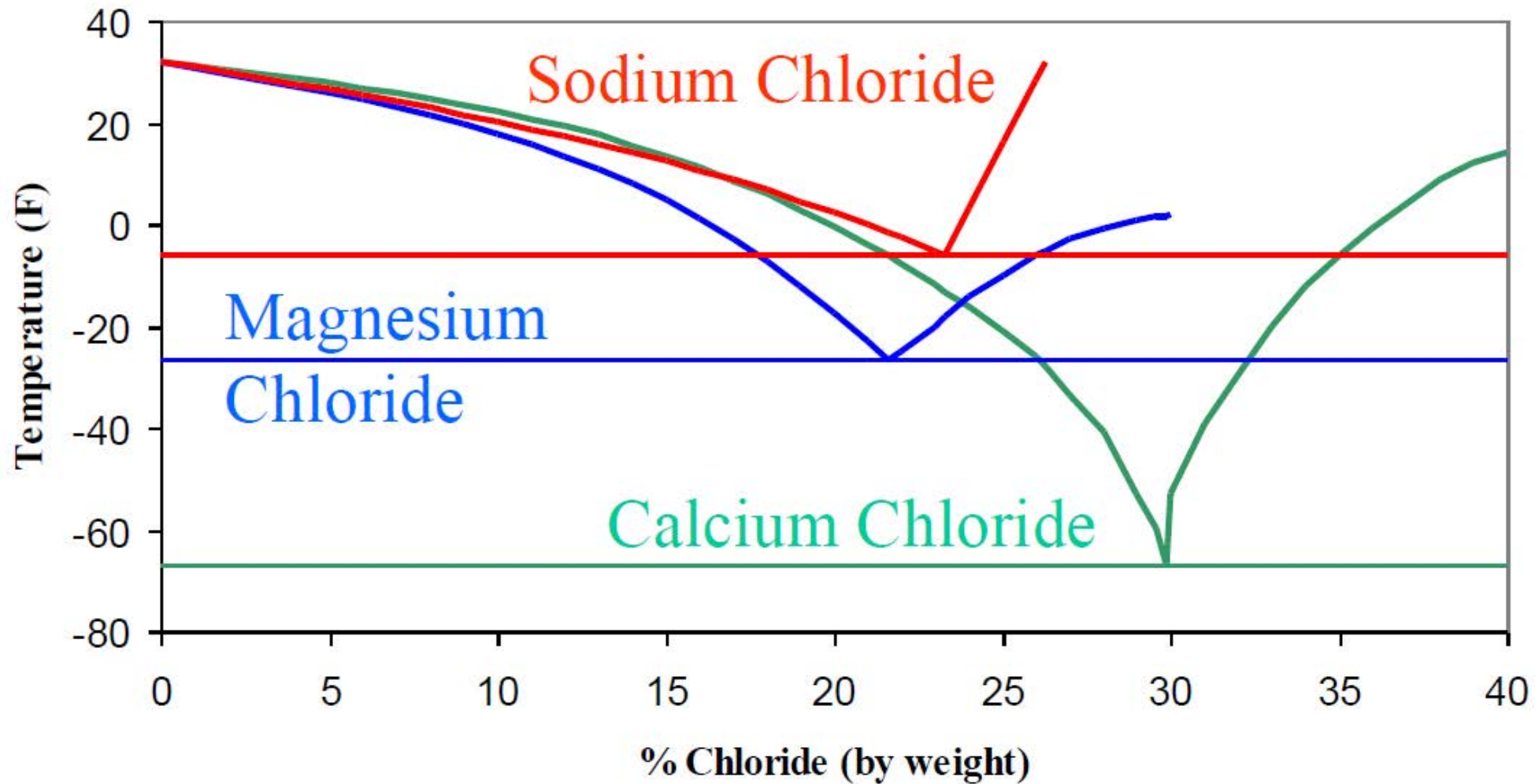
- 6 ° F

SALT BRINE - PHASE DIAGRAM



Data courtesy of the Federal Highway Administration (FHWA)

Phase Diagrams - Chlorides



What is:

The eutectic temperature of calcium chloride?

► - 60 ° F

The optimal concentration of a CaCl_2 brine?

► 30%

Any guesses how many pounds
of ice, one pound of salt will
melt at 30 °?

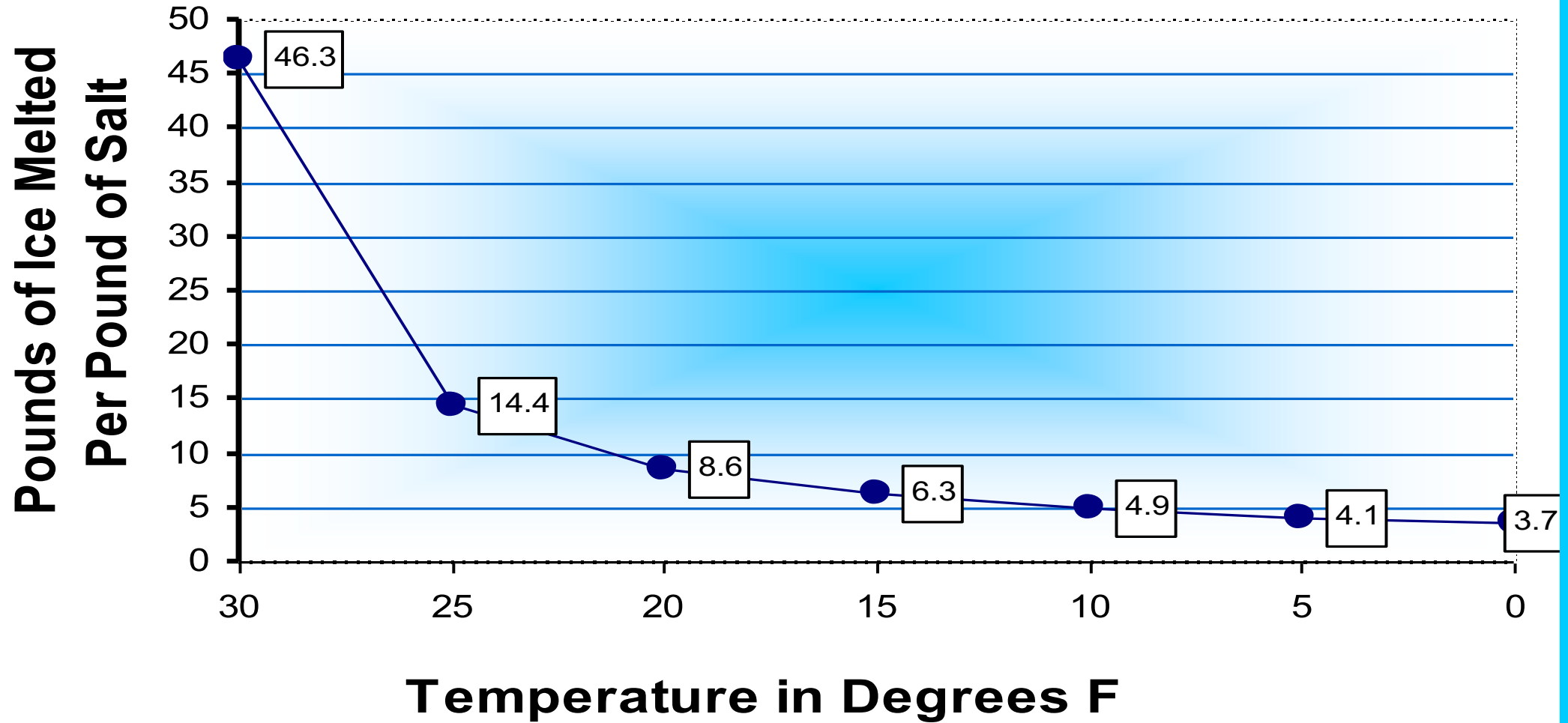


46.3 pounds of ice

Remember we are talking
road surface temperatures

What about at 20 °?

Melting Rates-NaCl

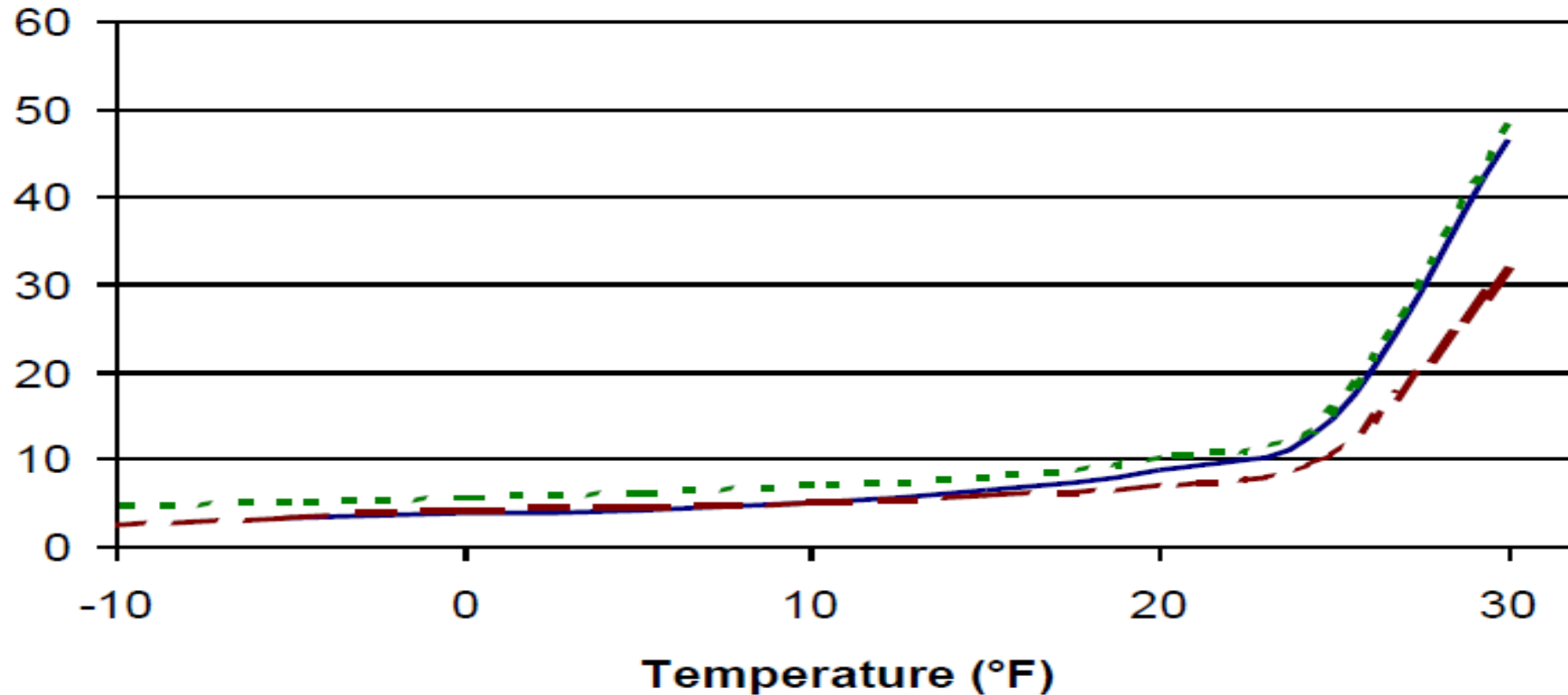




1 inch of ice/hard pack snow on one lane mile of road weighs 70 tons.

17 tons of salt is needed to melt this much ice at 30°F.

Pounds of snow melted with 1# of the various chloride products



— sodium chloride
- - - magnesium chloride

- - - calcium chloride

			Pounds/24 feet of pavement/mile			
Pavement temperature (F) and trend	Weather condition	Maintenance actions	Salt prewetted/pre-treated with salt brine	Salt prewetted/pre-treated with other blends	Dry salt	Winter sand (abrasives)
less than 30 F temp increasing	snow	Plow	80 lbs.	70 lbs.	100 lbs.	Not Recommended
	freezing rain	Apply chemical	80-160 lbs.	70-140 lbs.	100-200 lbs.	Not Recommended
30 F temp dropping	snow	Plow & apply chemical	80-160	70-140	100-200	Not Recommended
	freezing rain	Apply chemical	150-200 lbs.	130-180 lbs.	180-240 lbs.	Not Recommended
25-30 F temperature rising	snow	Plow & apply chemical	120-160	100-140	150-200	Not Recommended
	freezing rain	Apply chemical	150-200 lbs.	130-180 lbs.	180-240 lbs.	Not Recommended
25-30 F temperature dropping	snow	Plow & apply chemical	120-169 lbs.	100-140 lbs.	150-200 lbs.	Not recommended
	freezing rain	Apply chemical	160-240 lbs.	140-210 lbs.	200-300 lbs.	400 lbs.
20-25 F temperature rising	snow or freezing rain	Plow & apply chemical	160-240 lbs.	140-210 lbs.	200-300 lbs.	400 lbs.
20-25 F temperature dropping	snow	Plow & apply chemical	200-280 lbs.	175-250 lbs.	250-350 lbs.	Not recommended
	freezing rain	Apply chemical	240-320 lbs.	210-280 lbs.	300-400 lbs.	400 lbs.
15-20 F temperature rising	snow	Plow & apply chemical	200-280 lbs.	175-250 lbs.	250-350 lbs.	Not recommended
	freezing rain	Apply chemical	240-320 lbs.	210-280 lbs.	300-400 lbs.	400 lbs.
15-20 F temperature dropping	snow or freezing rain	Plow & apply chemical	240-320 lbs.	210-280 lbs.	300-400 lbs.	500 lbs. for freezing rain
0-15 F temperature rising or dropping	snow	Plow, treat with blends and sand high-traffic areas	Not recommended	300-400 lbs.	Not recommended	500-750 lbs., spot treat as needed
less than 0 F	snow	Plow, treat with blends and sand high-traffic areas	Not recommended	400-600 lbs.	Not recommended	500-750 lbs., spot treat as needed

The typical liquids

▶ Straight brines

- ▶ Sodium Chloride – 23% NaCl / 77% water solution
- ▶ Calcium Chloride – 32% CaCl₂ / 68% water solution
- ▶ Magnesium Chloride – 28% MgCl₂ / 72% water solution
- ▶ Potassium Chloride (KCl)

▶ Other Chemicals

- ▶ Urea
- ▶ Calcium Magnesium Acetate

▶ The organics

The organic additives all have significant rust inhibiting properties and lower freeze points

Agricultural by-products

- ❖ Sugar beet juice, IBG magic
- ❖ distillers, brewers
- ❖ whey

Other Additives

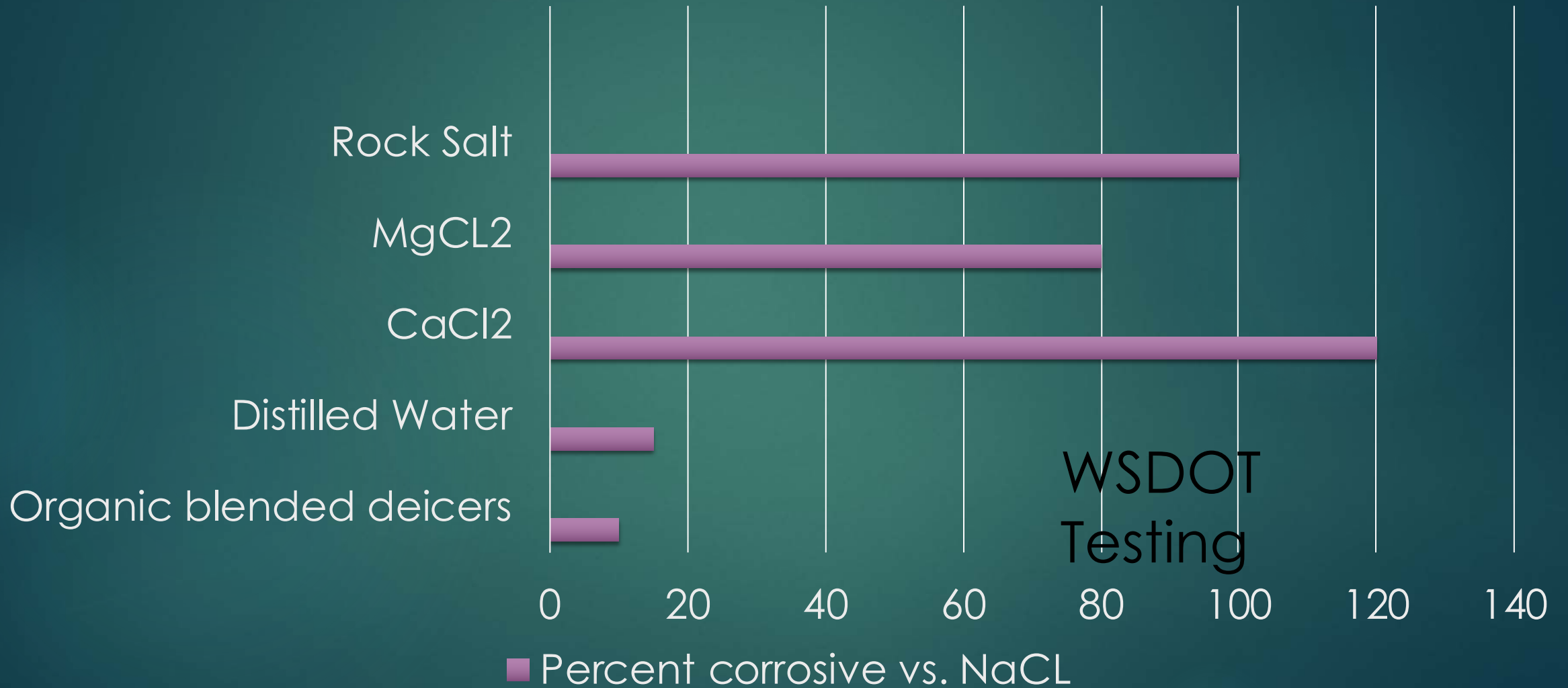
Lignosulfonate, Safemelt

Chemical rust inhibitors

Excalibur, Clearlane, Boost

Others?

Pacific Northwest Snowfighter's Corrosion comparison



Adding any of these liquids or additives in the appropriate concentrations will:


lower the freezing point of salt or salt brine,
add corrosion protection,
and **reduce scatter and bounce.**

Typical Scatter: Rock Salt



Typical Scatter: Rock Salt Pre-wetted With Calcium Chloride (32%)





The mag and calcium products
can be blended with salt at a rate
of **8** gallons/ton in a stockpile.
Anymore and it may leach out
depending on the salt's gradation

That's about 4.4% by weight. ClearLane has 3% mag. Don't forget that when you figure your cost/ton to mix your own.

You can also prewet with more product at the discharge, when appropriate, if equipped

Remember,

SALT BRINE CANNOT BE MIXED IN STOCKPILE

- DON'T DUMP SALT BRINE TREATED SALT BACK IN THE PILE. SPRAY AT DISCHARGE, NOT THE LOAD

MAG AND CALCIUM CHLORIDES DON'T MIX,

AT ALL!!!! EVER!!

SPRAYING DIFFERENT LIQUIDS MAY REQUIRE DIFFERENT NOZZLES, FILTERS AND EVEN PUMPS

Editorial comment:

If you aren't buying premixed salt, why aren't you treating your stockpile or vice versa?

More effective below 25 °. Below 0° do we even care?

No chunks or crust even after a year or more

Greatly reduced bounce and scatter. That's a lot of the advertised 30%+ reduction in salt use.

Increased retention of anti-icing and/or residual product.

No equipment purchase if you have tanks,
a pump and injection nozzle would be helpful.

Anti-icing

- ▶ Effective treatment unless rain is expected
- ▶ Usually salt brine with **appropriate additives for road surface temperatures**
- ▶ Generally, politically unacceptable at this time and place
- ▶ Public perception about corrosion needs to change



Getting ready for Salt application

- ▶ How many pounds /lane mile or centerline mile? **Are you CALIBRATED ?!?! Do you have charts and protocol in place?**
- ▶ Can you salt under the truck, **one lane, reverse spinner, slide?**
- ▶ Rate of speed? CW **....< 20 MPH**
- ▶ Do you have ground speed control ?
- ▶ Do you have mounted road temperature sensors



We should use salt to keep snow and ice from bonding to the pavement so we can plow it off. Removing ice-pack is very costly.

- ▶ **Plowing is the most effective and efficient way to remove snow**



1. Start early and get some salt down especially if you don't anti-ice or have residual. 250# per lane mile, 500# per road mile

2. Plow your round and reapply as needed to prevent bonding maybe 200# or less.

3. Ice is a different bag but trying to maintain a layer of brine to prevent bonding to the road keeps it slushy, maybe plowable.

4 .Watch the temperature, below 10° and certainly below zero, do we need to salt?



And that's all, Folks!

Questions, Arguments, Fist-a-cuffs?