



STALAM
Radio Frequency Equipment

IN LINE RAPID DEFROSTING



Established in 1978, STALAM is a **world leader** in the development, design and manufacture of equipment where capacitive electromagnetic fields at I.S.M. metric frequencies (RF fields) are exploited for a variety of heating and drying applications on raw materials, intermediate and finished industrial products.

As a member of AEI (Italian Electronic and Electro-technical Association) STALAM co-operates actively with prestigious universities and research institutes for the development of the RF technology both as to generation techniques and to technological applications.

STALAM also co-operates with other leading machinery manufacturers for the development of innovative technologies and for the supply of "turn key" automated and integrated processing lines.



Presently, more than 2000 STALAM radio frequency machines are in operation in the world, with rated power values ranging from 3 to 450 kW; from the simple, manually operated machine, to the fully automated line complete with computerised control and supervision systems.

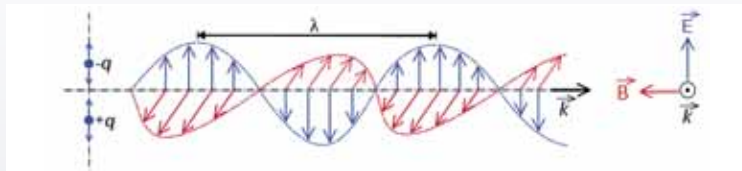
Exporting over 90% of its production to the five continents, STALAM provides professional and prompt commercial and technical assistance in all the relevant areas throughout the world.

4	RF In Line Rapid Defrosting
6	Beef / Pork / Poultry etc.
10	Fish and Seafood
14	Vegetables / Fruits / Ready meals / Dairy products etc.
15	Technical Data

HOW THE RF TECHNOLOGY WORKS

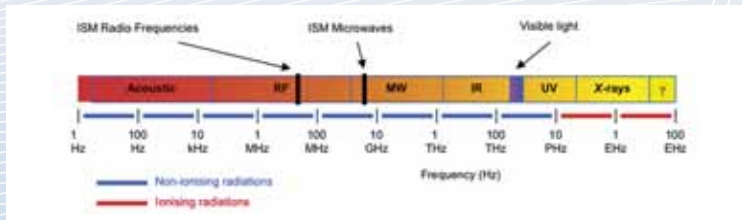
ELECTROMAGNETIC WAVES

Electromagnetic waves are formed by the combined and simultaneous action of electric and magnetic fields, whose intensity varies cyclically with a certain oscillation frequency.



Thanks to the interaction effects of electromagnetic waves with the matter (atoms, molecules, ions), under specific conditions it is possible to generate heat directly inside several materials. The heating mechanism depends on the frequency of the electromagnetic waves applied and on the specific chemical and physical characteristics of the material.

Since Radio Frequencies (RF) are widely utilised by radio communication systems, in order to avoid interferences the competent authorities have allocated specific frequency ranges (bands) to be used worldwide for ISM (Industrial, Scientific, Medical) purposes. Permitted frequencies within the RF range of industrial significance for dielectric heating applications are: 13.56, 27.12 and 40.68 MHz.

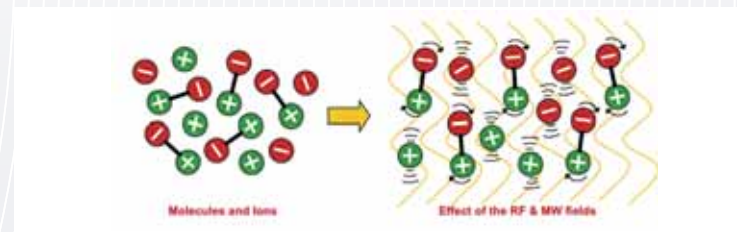


DIELECTRIC HEATING

If we exclude the materials, in particular metals, which are good conductors of electric current, in all other materials subjected to electromagnetic fields, heat will be generated mainly due to the so called "dielectric losses".

Dielectric losses are caused by the vibration and rotation of polar or polarised molecules, and by the polarisation and translation movement of ionic particles present in the material, induced by the quick (several million times per second) polarity reversal of the electromagnetic field.

This can be interpreted as if the electromagnetic field is absorbed and converted into thermal energy by the effect of the rapid movement of polar(ised) molecules and ions. Water molecules are highly polar, more than all substrates in which water can normally be found, and many ionic species are usually dissolved in water. Therefore, RF electromagnetic fields can heat up very quickly materials containing water. In particular, RF has the ability to evaporate water very quickly, efficiently and selectively from many substrates (textiles, agricultural commodities, baked products, etc.).



ADVANTAGES OF DIELECTRIC HEATING

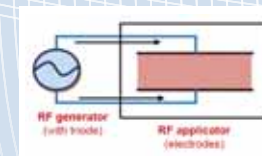
Radio Frequencies generate heat directly inside the products, in depth and instantly. On the contrary, with traditional methods first the heat is generated outside the product and is then transferred to it by means of the well known heat transfer mechanisms (conduction, convection, radiation). The endogenous (volumetric) heat generation is the key that makes the RF heating methods fast, efficient and ensures the best product quality while eliminating all typical drawbacks of conventional methods (slow heating, surface overheating, heat losses to the environment, etc.).

TYPICAL STRUCTURE OF A RADIO FREQUENCY HEATING EQUIPMENT

Generally speaking, all RF heating equipment consist of two main distinct parts:

- the generator
- the applicator (or electrodes)

The generator converts the normal electricity from the mains supply into radio frequency electromagnetic energy. It is composed of a suitably designed combination of capacitors and inductances (the oscillating LC circuit) connected to a vacuum valve (the triode), complete with the high voltage DC supply unit.



The applicator receives the electromagnetic energy from the generator through simple conductive metal connectors and applies it to the product to be heated.

RF IN LINE RAPID DEFROSTING



"RF 85 kW" defrosting equipment for mackerels and sardines.

TRADITIONAL DEFROSTING

The traditional defrosting methods introduce a number of difficulties directly related to the heat transfer mechanisms: **slow process** (hours, sometimes days); **bacteria growth** in the product; **high drip loss** (economic loss); **deterioration** of the product surface; **batch processing** (high handling costs, risk of breakage, bruising and other damages to the product due to such handling).

RADIO FREQUENCY DEFROSTING

The drawbacks of the conventional defrosting methods can be avoided, thanks to the ability of RF to rapidly generate heat **volumetrically within the product**. The heating process is **uniform and controlled**, resulting in a significant **reduction of drip losses**. It also offers **great flexibility** in the production schedules and is the ideal solution for many tempering, softening and thawing processes.

The product is placed on the machine's conveyor belt and is transferred through the RF unit (tunnel) passing between upper and lower metallic plates (electrodes). When the RF generator applies high frequency alternating voltage between these plates, the dipolar water molecules of the frozen product will vibrate and rotate in the attempt to align themselves according to the fast changing opposite plates polarities. This phenomenon

causes intermolecular friction, which will in turn generate heat rapidly and uniformly within the whole product mass **regardless of its size, weight, shape and thermal conductivity**.

The amount of heat generated inside the product and the defrosting time are accurately controlled through the voltage applied on the electrode plates and the speed of the conveyor belt.



"RF 3x85 kW" defrosting equipment for turkey breast and pork.

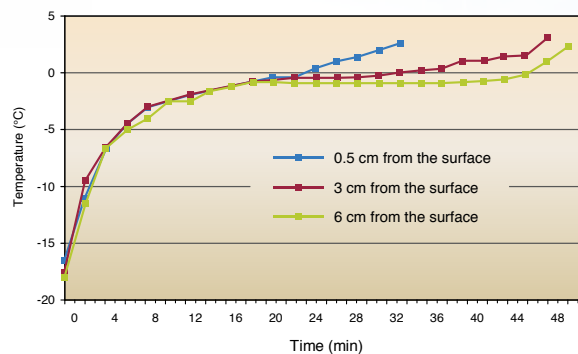
BENEFITS OF THE RF DEFROSTING METHOD

- defrosting is achieved in **minutes** rather than hours/days, even for large product blocks and, if necessary, directly inside packaging used for storage (carton boxes, polyethylene liner/bags, plastic crates, etc.);
- the **process speed** and **uniformity** minimise product degradation: **No drip loss**; No deterioration of sensorial, chemical or physical properties; **No bacterial growth**. Thus, the very best product quality is preserved;
- the product can be obtained at the correct temperature needed for the next stage of processing;
- radio frequency defrosting can be carried out **continuously**, with significant logistics advantages in product handling and production scheduling. The production can be organised according to **"just-in-time"** criteria - a great advantage in case of sudden orders, last-minute changes in the order under processing, etc.;

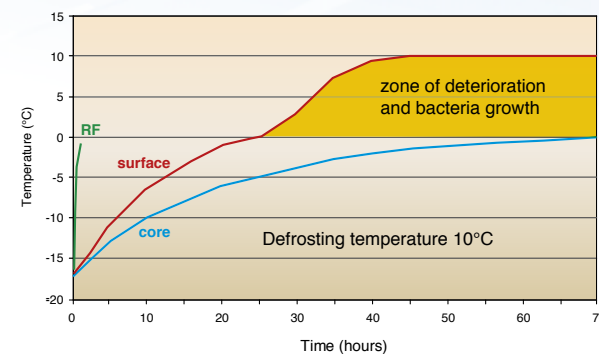


"RF 85 kW"
defrosting equipment.

- radio frequency equipment requires much **less floor space** compared to the traditional, large defrosting rooms or equipment; **overall processing costs can be reduced drastically** compared to conventional techniques.



Radio frequency defrosting of a 12 cm thick block of pork meat.



RF vs. conventional defrosting of a 12 cm thick block of deboned beef meat.

BEEF / PORK / POULTRY ETC.

BEEF & LAMB:

trimming, muscles, oyster, tenderloin, shoulder, breast, neck, shin, shank, tongues, kidneys, lungs, etc. with different % of fat content.

PORK:

shoulder, ham, trimming, loins, back, belly, leg, fillets, shin, neck, etc. with different % of fat content.

POULTRY (chicken, turkey, duck, etc.):

fillets, breasts, thighs, wings, drumsticks, legs, bone-in or bone-less, skin, MDM, trimming, etc.

GAME: deer, hare, roe, reindeer, doe, etc.



"RF 85 kW"
defrosting equipment
for pork.

"RF 4x60 kW"
defrosting
equipment
for pork
and beef.



Beef trimming 15% fat



Beef kidney



Beef trimming 20% fat



Beef shoulder clod



Beef trimming 25% fat



Beef striploin



Beef tongue



Beef neck



Beef chuck



Beef sausages



Lamb trimming 35% fat



Pork trimming 30% fat



Beef cut for pastirma



Roast beef



Pork trimming 10% fat



Pork shoulder



Beef entrecote



Lamb rolled shoulder



Pork trimming 15% fat



Pork shin



Beef shin



Lamb trimming 15% fat



Pork trimming 20% fat



Pork cheeks

BEEF / PORK / POULTRY ETC.

Format:

IQF or blocks. Thanks to the multi-position upper electrode system and the wide conveyor belt, the machine accepts a wide range of sizes and weights: from few kg to 30 kg and from few cm to 23 cm high (standard configuration). Upon request, the machine can be customized for processing taller blocks.

Packaging:

thanks to the characteristics of the RF field and the different types of conveyor belt available, the meat can be processed packaged (in PE film/liner or bag, open or vacuumed, PE + carton, PP crates or trays, etc.) or "naked".

Defrosting level:

from mild tempering (from -18°C to around -5 / -3 °C in 10-20 minutes) for grinding, cutting, slicing, portioning, forming, dicing, mincing, flaking, etc.; to partial thawing (from -18°C to -3 / -1 °C in 25-40 minutes) for tumbling, marinating, deboning, etc.

"RF 2x85 kW"
defrosting equipment
for turkey and chicken.



"RF 2x85 kW"
defrosting equipment
for beef.



Pork oyster



Pork ribs



Pork pope's eye



Pork belly



Pork loin



Shoulder 4D boneless



Pork back



Pork ham



Pork neck



Cooked chicken strips



Chicken MDM



Bone-in venison ribs



Chicken breast



Chicken wings



Turkey thigh



Roe muscle



Chicken innerfillets



Chicken drumsticks



Turkey breast



Doe fillet



Chicken thigh



Chicken skin



Venison



Roe fillet

FISH AND SEAFOOD

Different species of fish and seafood, whole, H&G, fillets, loins, steak/chunks, shell-on or peeled can be RF defrosted: squid, calamari, octopus, scallops, mussels, sardines, salmon, tuna, swordfish, shrimps, prawns, crawfish, lobsters, cod, pollock, hake, pangasius, halibut, catfish, toothfish, surimi, etc.



"RF 85 kW" defrosting equipment for fish fillets.



"RF 85 kW" defrosting equipment for mackerels.



Hake fillet block



Haddock fillet block



Cod fillet block



Minced cod block



Pollock fillet block



Surimi block



Salmon fillets (3 layers overlapped)



Crabmeat block



Pangasius fillets



Shell-on shrimps in bag



IQF shell-on shrimps



Shrimp rings with sauce



Hallibut fillets



Shell-on shrimps in block



Breaded prawns



Shrimps carpaccio



PUD shrimps in block



IQF shell-on prawns in bag



PUD shrimps in tray



Shrimps for sushi



IQF PUD shrimps in bag



Shell-on whelk



Shrimp skewers



Crawfish

FISH AND SEAFOOD

Format:

IQF and blocks. Thanks to the multi-position upper electrode system and the wide conveyor belt, the machine accepts a wide range of sizes and weights: from few kg to 30 kg and from few cm to 23 cm high (standard configuration). Upon request, the machine can be customized for processing heavier blocks.

Packaging:

thanks to the characteristics of the RF field and the different types of conveyor belt available, the product can be processed packaged (in PE film/liner or bag, open or vacumeed, paper film, PE + carton, PP crates or trays, etc.) or "naked".

Defrosting level:

from mild tempering (from -18°C to around $-5 / -3^{\circ}\text{C}$ in 5-20 minutes) for re-packing, sawing, cutting, grinding, supplying to supermarket chains, etc.; to partial thawing (from -18°C to $-3 / -1^{\circ}\text{C}$ in 25-40 minutes) for grinding, forming, portioning, gutting, cooking, marinating, etc.



"RF 85 kW" defrosting equipment for H&G salmon and other types of fish.



"RF 85 kW" defrosting equipment for herrings, hallibuts, grey sole.



"RF 85 kW" defrosting equipment for squid, shrimps, etc.



"RF 85 kW" for pollock fillets.



Half shell lobster



IQF scallop



Seafood in tray



IQF mussels bag



Shell-on mussels



Squid



Sardines



Red fish block



Raw tuna chunks & steaks



Octopus



H&G salmon



Grey sole block



Tuna loin



Mackerel



Whole salmon



H&G halibut block



IQF baby squid bag



Herring fillets block



Siberian salmon block



Toothfish

VEGETABLES / FRUITS / READY MEALS / DAIRY PRODUCTS ETC.

VEGETABLES:

carrots, corn, zucchini, tofu, spinach, peas, onions, seaweeds, butternut, potatoes, chili, etc.

FRUIT:

strawberries, apples, etc.

OTHER:

butter, margarine, ice-cream, liquid eggs, ready meals, etc.

Format:

IQF or blocks. Thanks to the multi-position upper electrode system and the wide conveyor belt, the machine accepts a wide range of sizes and weights: from few kg to 30 kg and from few cm to 23 cm high (standard configuration). Upon request, the machine can be customized for processing taller blocks.

Packaging:

thanks to the characteristics of the RF field and the different types of conveyor belt available, the product can be processed packaged (in PE film/liner or bag, open or vacuummed, PE+carton, PP crates or trays, etc.) or in bulk.

Defrosting level:

from mild tempering (from -18°C to around -5 / -3 °C in 5-10 minutes) for grinding, cutting, slicing, dicing, mixing, flaking, etc.; to partial thawing (from -18°C to -2 / -1 °C in 15-30 minutes) for further processing.



IQF carrots



IQF zucchini dice



Tofu block



Butter block



Peas



Seaweed salad



Red chili



Margarine block



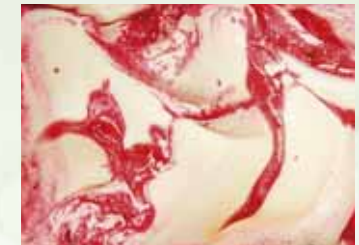
IQF mixed vegetables



Butternut block



Strawberry



Ice cream



Spinach block



Peeled potatoes



Ready meals



Egg white and yolk

Specific features of the RF defrosting equipment

- Radio Frequency at **27,12 MHz**.
- Construction in AISI 304 stainless steel submitted to anti-corrosion treatments (passivation, pickling) and shot-peening finish.
- Protection level **IP65**: the external protection boxes of the RF generator are made of insulating sandwich-type panels with sheeting and bearing frame in AISI 304 stainless steel.
- **Wide conveyor belt** (up to 180 cm) made of certified food-grade rigid polyethylene modules (for packaged products) or solid-surface reinforced polyester (for "naked" products).
- Built-in conveyor **belt & tunnel washing facilities** and full internal access for cleaning through the multiple side panel doors.
- **PLC control system** for multiple product recipes.



Washing system drainage.



Conveyor belt washing system.



Designed to be easily and fully washed.



NEW PLC and user-friendly interface.

Technical Data

RF power (kW _{RF})	Dimensions LxWxH (m)	Belt width (m)	Additional module length (m)	Generator cooling system	Throughput of one module (Kg/h)
3	1.1x0.8x1.6	batch unit	not available	air	60 - 200
7	4.2x1.4x2.6	0.6	not available	air	90 - 350
20	5.7x2.0x3.6	1.4	not available	air	250 - 1,000
40	7.7x2.0x3.6	1.4	not available	air or water	500 - 2,000
85	9.2x2.4x3.6	1.8	5	water	1,000 - 4,000
105	9.2x2.4x3.6	1.8	5	water	1,000 - 5,000

Production capacities can vary depending on the type and weight of product to be defrosted and the final temperature required. Multiple modules can be combined to increase the production capacity even at a later stage as production requirements increase with business growth.

Main advantages of the RF vs. MW defrosting technology

- A simple but effective "rule of thumb" states that the non-ionizing electromagnetic waves (to which RF and MW belong to) can **penetrate** dense materials up to a depth of about 1/10 of their wavelength, that is **11 m for RF 27.12 MHz** and 32 cm for MW 915 MHz. It means that, whilst radio frequencies can easily heat up uniformly a product whose size is in the range of a meter, microwaves can penetrate only smaller layers, in the range of a few centimeters.
- The RF field is uniform between the electrodes; the product absorbs the RF energy **evenly and diffusely**, notwithstanding its shape and size. On the contrary, MW is irradiated into the process volume by a multiple point-source; the energy absorption by the product is a random (statistical) phenomenon which cannot be controlled accurately; an uneven treatment is common, especially when a batch machine is used.
- The MW power is "emitted" in pre-determined quantities by the generator, while the RF power is just "made available" to the product; contrary to MW:
 - the RF power delivered is "**self-adjusting**" according to the actual product mass between the electrodes;
 - the specific RF energy (Wh/kg) absorbed by the product does not depend on the quantity of product fed to the machine;
 - with RF the target product temperature is achieved **consistently and uniformly** irrespective of product flow;
 - with RF higher temperature targets can be attained **safely**.
- In STALAM RF defrosters, the generator, its cooling system, the electrical board & controls, are all placed on the top of the process tunnel, suitably enclosed in an IP65 cubicle. Consequently, there is no need for a separate room or a "mezzanine" to place the generators and its ancillary devices & controls, as required by commercial MW defrosters.
- Long inlet & outlet tables combined with a wide conveyor belt that can accommodate a large quantity of product at once, do not require the continuous presence of the operator for the machine loading and unloading operations.

STALAM

Radio Frequency Equipment



Stalam S.p.A.

Via dell'Olmo, 7 (Z.I.) - 36055 NOVE (VI) - Italy

Tel. +39 0424 597400 • Fax +39 0424 590722

e-mail: stalam@stalam.com • <http://www.stalam.com>