

AUTOMATIC COATING TECHNOLOGIES

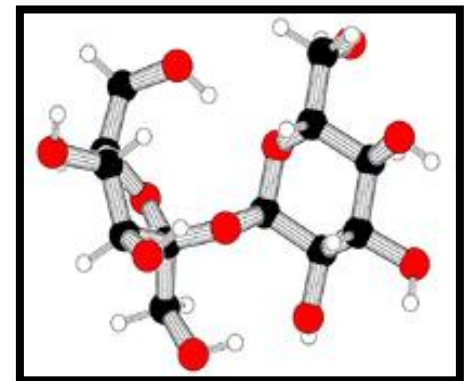
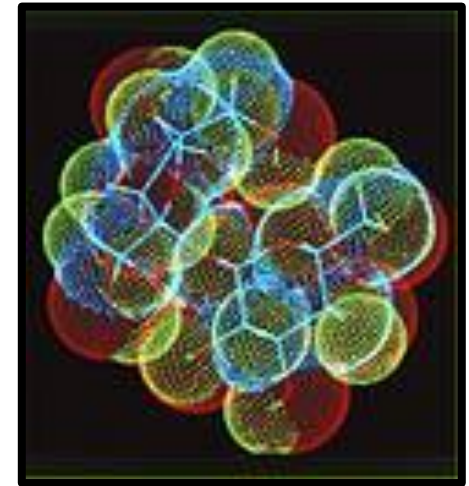
Dumoulin

SUGAR COATING

THE SUGAR

Sugar molecule

Sugar, sucrose or saccharose is an organic molecule made of carbon (C), hydrogen (H) and oxygen (O). Sugar chemical formula is $C_{12}H_{22}O_{11}$, with a molecular weight of 342,30 g/mol. More accurately, the saccharose is a combination of two molecules, fructose and glucose. Its official name, following international regulation, is D-fructofuranosyl of D-glucopyranoside



THE SUGAR

Sugar crystal

As a solid (crystallized), the saccharose or sugar do not have any color or smell, it got, of course a sugar flavor. Sugar crystallize on anhydrous prisms (which do not contain any water), with a monoclinic crystalline system (for purists).

Theoretically, perfect sugar crystal will be a 15 faces prism.



SUGAR COATING

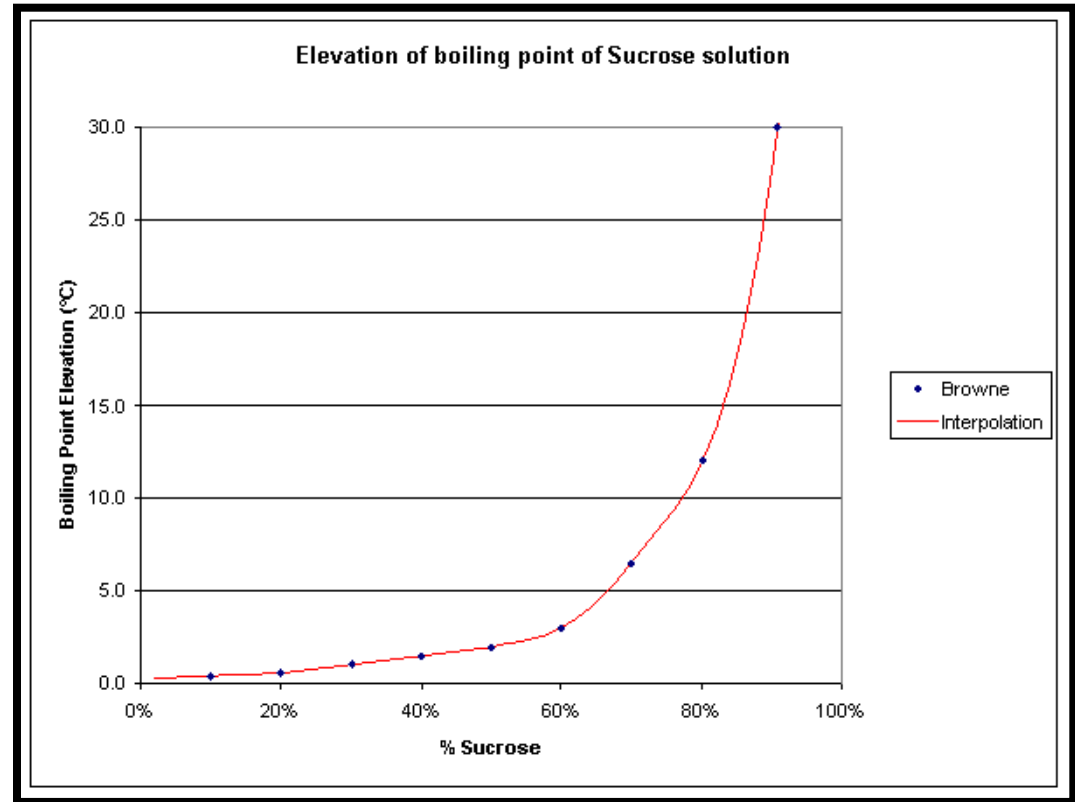
Sugar coating will allow

- To mask taste / odor / color (of the core)
- To give humidity and mechanical resistance,
- To keep or add crispness
- To facilitate packing
- To color / give shiny effects
- To add flavor
- To improve physical properties of the core
(Stability in the presence of heat, light, air,
reasonable levels of moisture, hardness, friability reduction)



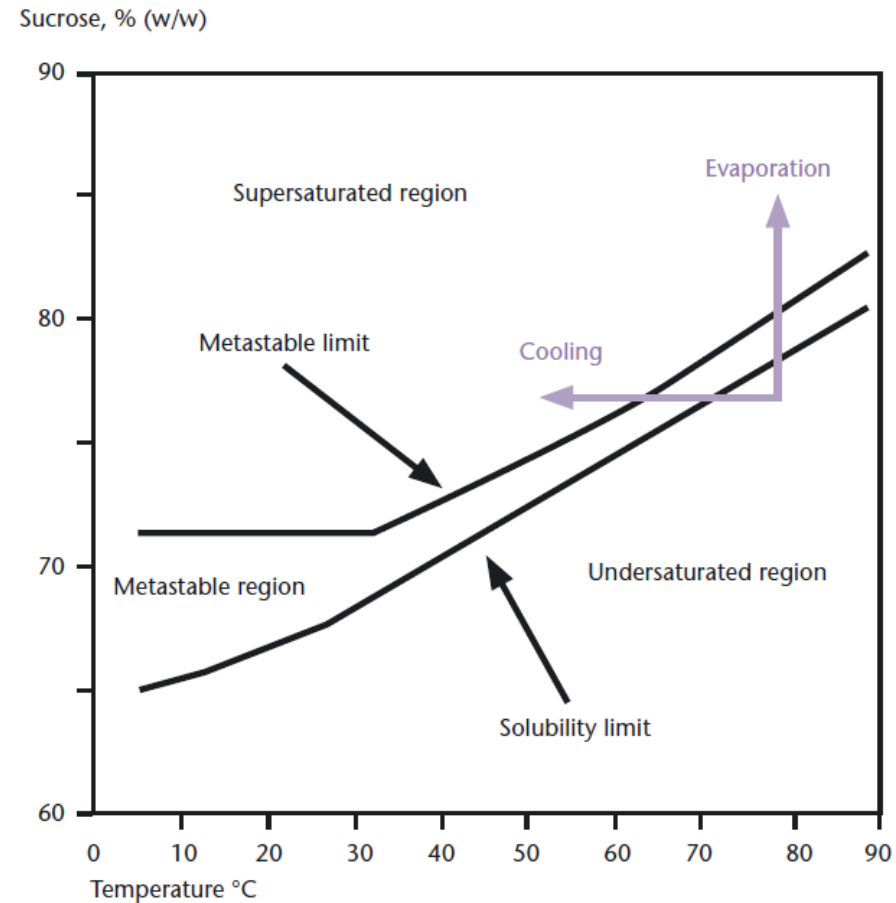
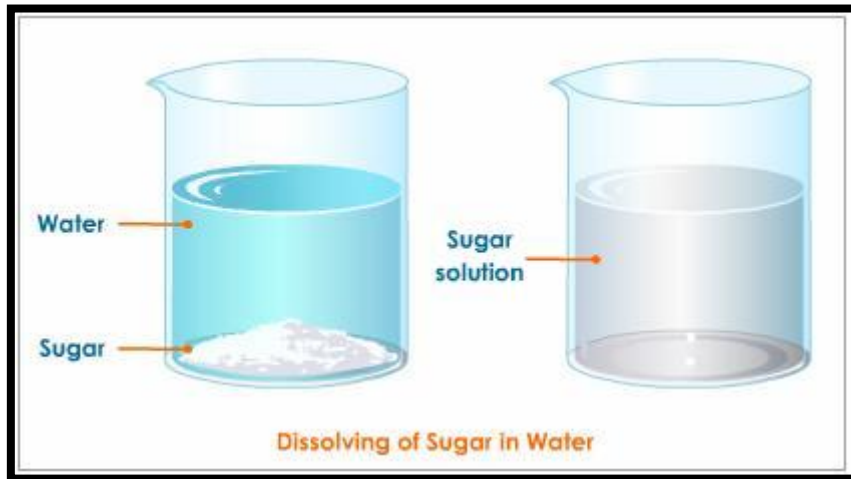
THE SYRUP

In cooking, a **syrup** is a thick, viscous liquid consisting primarily of a solution of sugar in water. In order to eliminate all sugar crystals (avoiding germination of random crystals), the syrup need to be boiled and crystals dissolved.

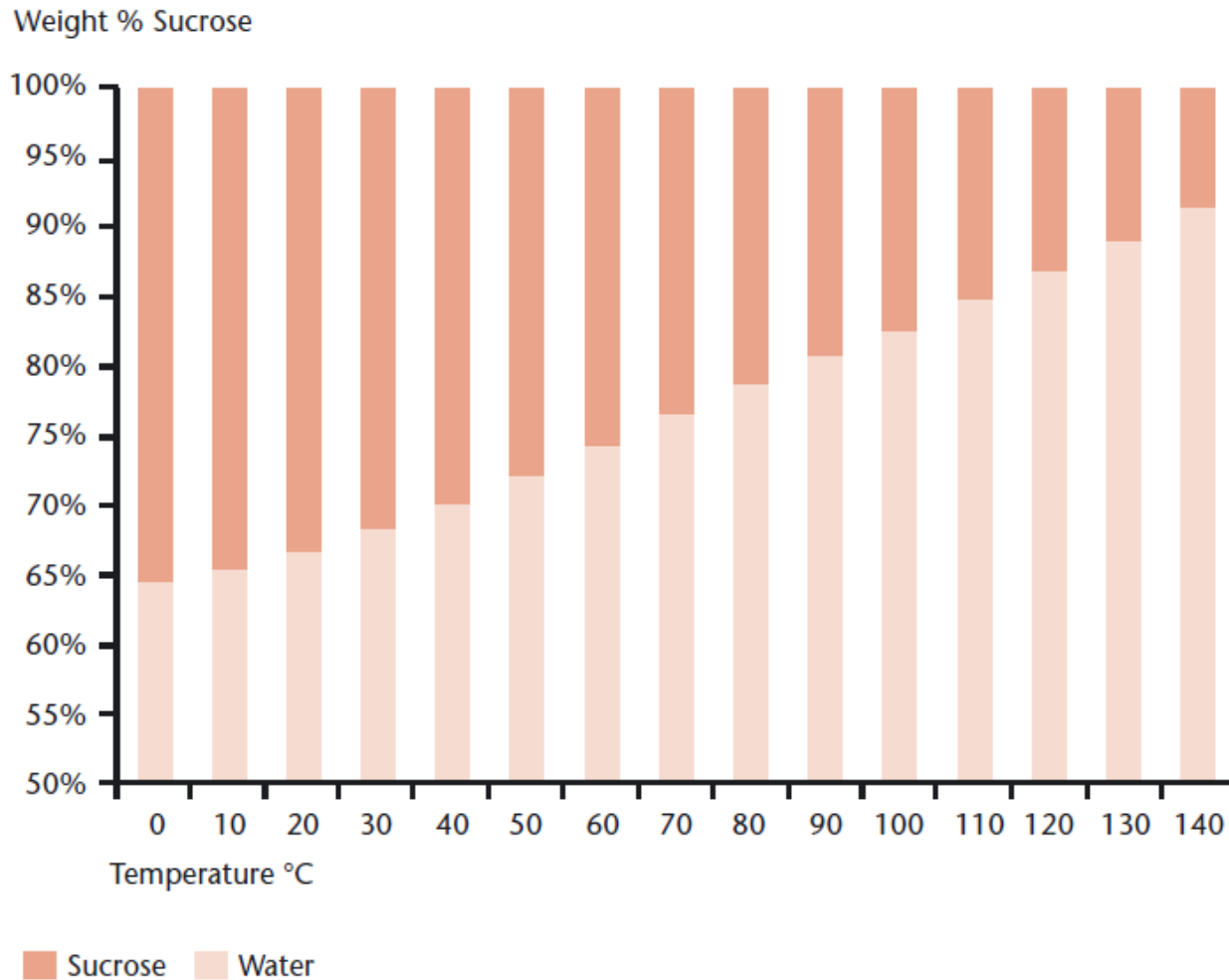


THE SYRUP

The syrup can then, be kept at a higher temperature than its solubility temperature, to avoid re-crystallisation.



THE SYRUP



THE SYRUP

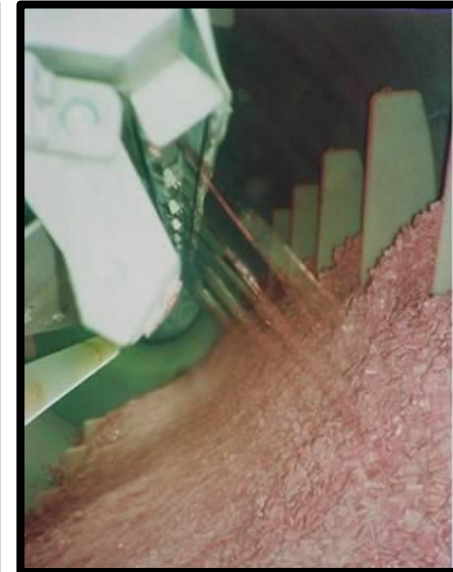
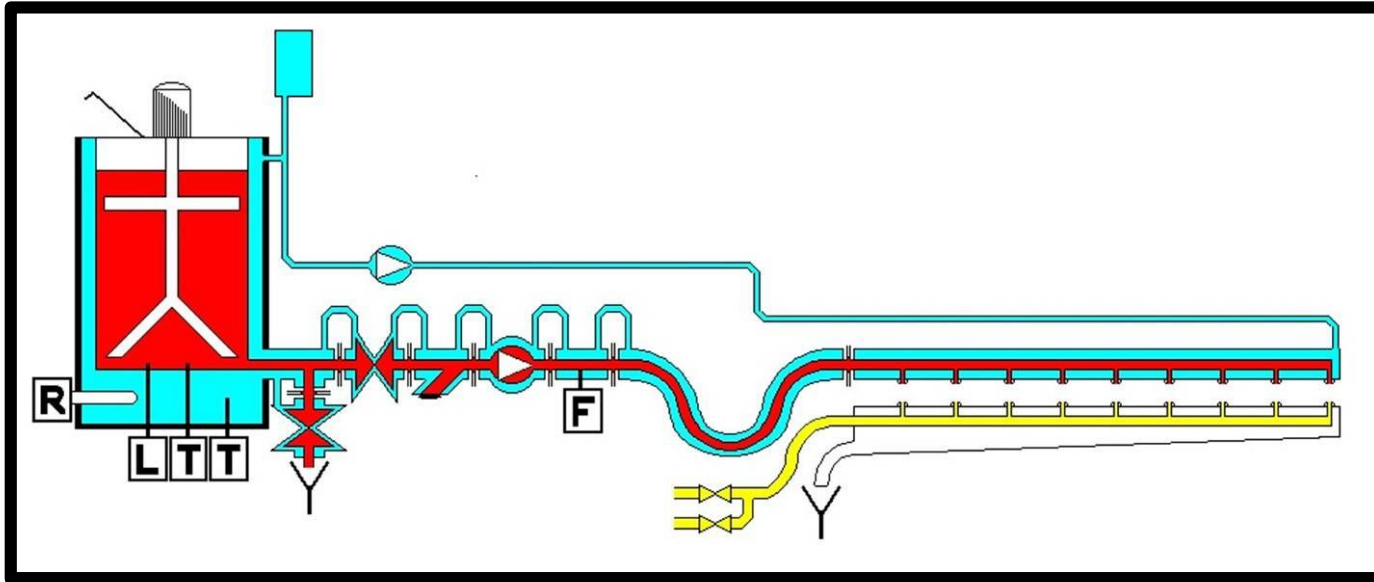
Syrup is usually supersaturated with 62 to 80% sugar concentration (above 65% they need to be heated), and some additives to the syrup can be added (more flexibility to the shell, binding, colors, flavors, adhesives etc...)

Syrup additives

Glucose syrup
Wheat starch
Rice starch
Gelatine
TiO₂
Gum arabic
Color

SUGAR OR SUGAR FREE COATING

The sugar (or sugar free) coating is done by means of air less spray nozzles using stainless steel lobes pump.



For these different systems, multiple options and ancillary equipment are available such as the tanks for the preparation of the solutions. Control and regulation of the liquid flow for the complete set of nozzles. Installations are equipped with an automatic extraction of the spraying bar allowing an easy access for maintenance, adjustment of the nozzles and quick change for the type of spray.

SUGAR COATING PROCESS

The sugar coating is traditionally a quite long process (from 4 to 24h), where layers of sugar are alternatively dried one after the other.

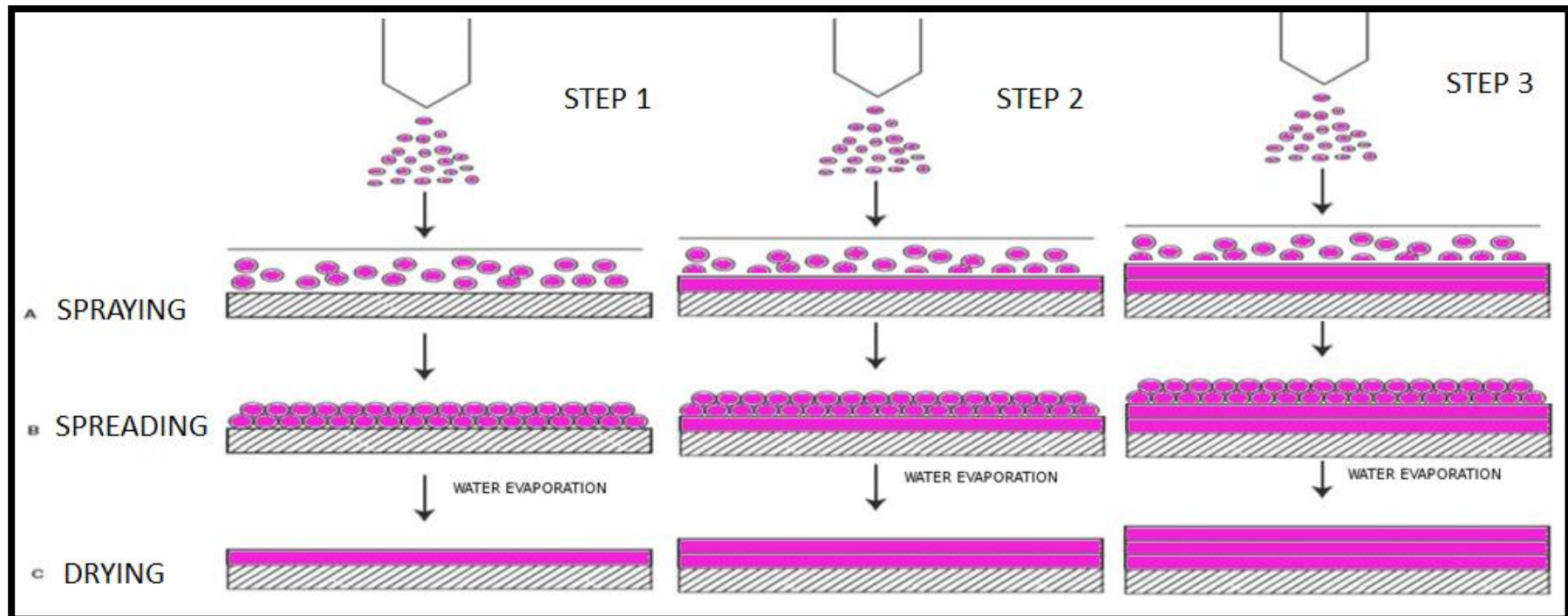
The quantity to be sprayed on each layer will depend of the surface of the product (which will vary during the process), and the final surface we want to reach.

Bigger quantity of syrup will be used middle of the process to built as fast as possible, smaller quantity of syrup (even lighter syrup) will be used at the end to get a surface as smooth as possible.



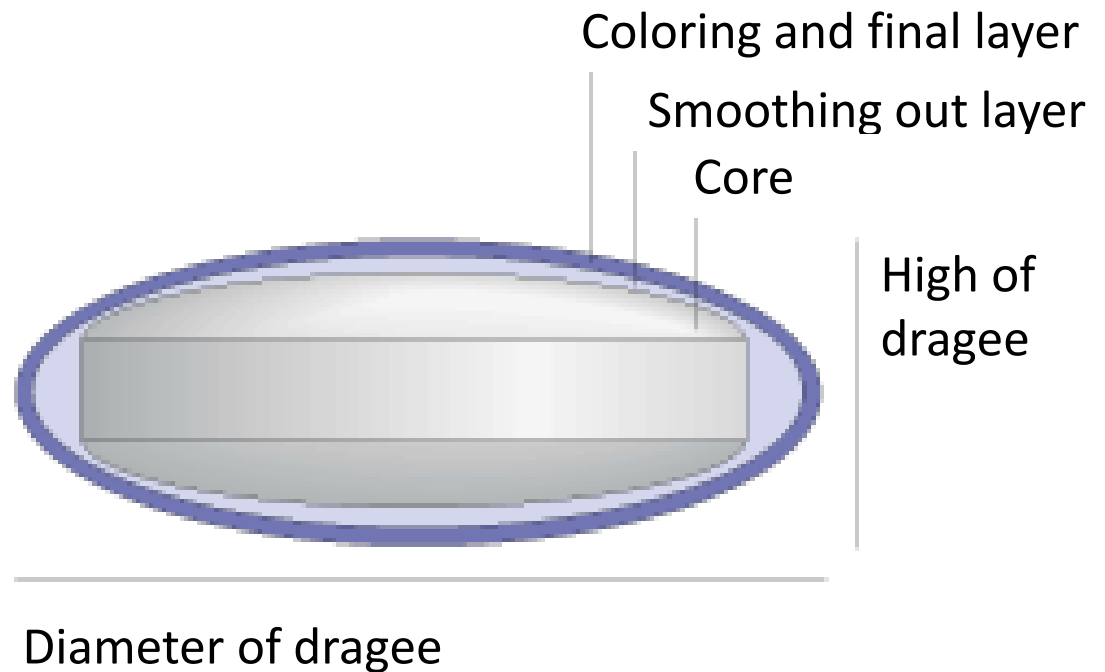
SUGAR COATING FORMATION PROCESS

The sugar shell of a Smartie or M&M's (30 % coating on finished product), will be formed with some 50 to 70 steps.



SUGAR COATING FORMATION PROCESS

- **Waterproofing or Sealing**
- **Engrossing - this is where the weight comes on**
- **Coloring and Finishing**
- **Polishing**



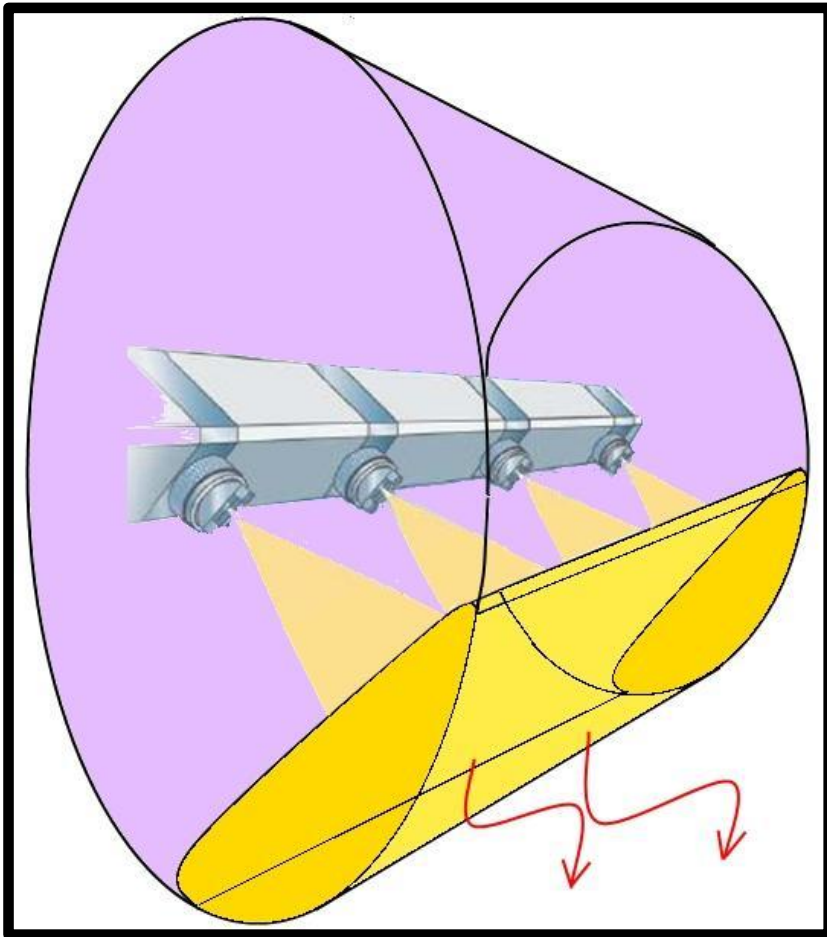
WATERPROOFING OR SEALING

- Most centers used for coating are stable enough to survive the coating unharmed. For this reason, it's only necessary to stabilize the centers in few cases.
- The main reason is highly moisture sensitive products, fat migration or specific roughness. Then prior sealing is required.

- Varnish
 - Resin
 - Gum
- |—— Dissolved in a solvent

Some cores are sticky (and can't be stored prior to coating), some are not stable (volume variation or crystallization not finished, some could be too soft for being hard coated)

PROCESS PARAMETERS



- Many quality aspects of the final coated product are greatly influenced by the combined effect of process parameter values used in sugar coating.
- Coating process parameters affect the spreading, penetration and drying (i.e. evaporation of water) of the coating liquid on the core surface and, subsequently, the surface roughness and the residual moisture of the coated products.

SPRAY FLOW

The spraying flow disperse the coating liquid into a film and then give a better distribution to the syrup on the cores.

For practical reasons, airless nozzles are normally used, the flow to be used will just match the best spray pattern.

This one depending of viscosity (concentration and temperature) of syrup used. Quantity of syrup per step is the important factor, The flow is not.



SYRUP SOLUTION QUANTITY PER STEP

The spraying quantity per injection is a key factor in sugar coating. Too small injection will not cover the whole surface and cause rough surface, too big injection will cause doubles. The standard way is to have small injection at the beginning to avoid interface problems. As soon you have injection of syrup onto a sugarized surface, quantity will be gradually increased, in order to go as fast as possible. During smoothing phase, quantity are gradually decreased (surface reduction), to fill smaller and smaller holes (spreading time is also then increased).

INLET AIR TEMPERATURE

- The pan air temperature effects drying efficiency of the coating pan and the uniformity of the coatings.
- High inlet air temperature increases drying efficiency of sugar coating process and decreases in water penetration into the core.
- Excessive air temperature increases premature drying of the spray during application and subsequently decreases the coating efficiency.
- Excessive air temperature may affect the core (chocolate chewing gum) structure.
- Excessive air temperature may affect the sugar crystal structure (too big crystal) and then the crunchiness of the sugar shell.

INLET AIR FLOW

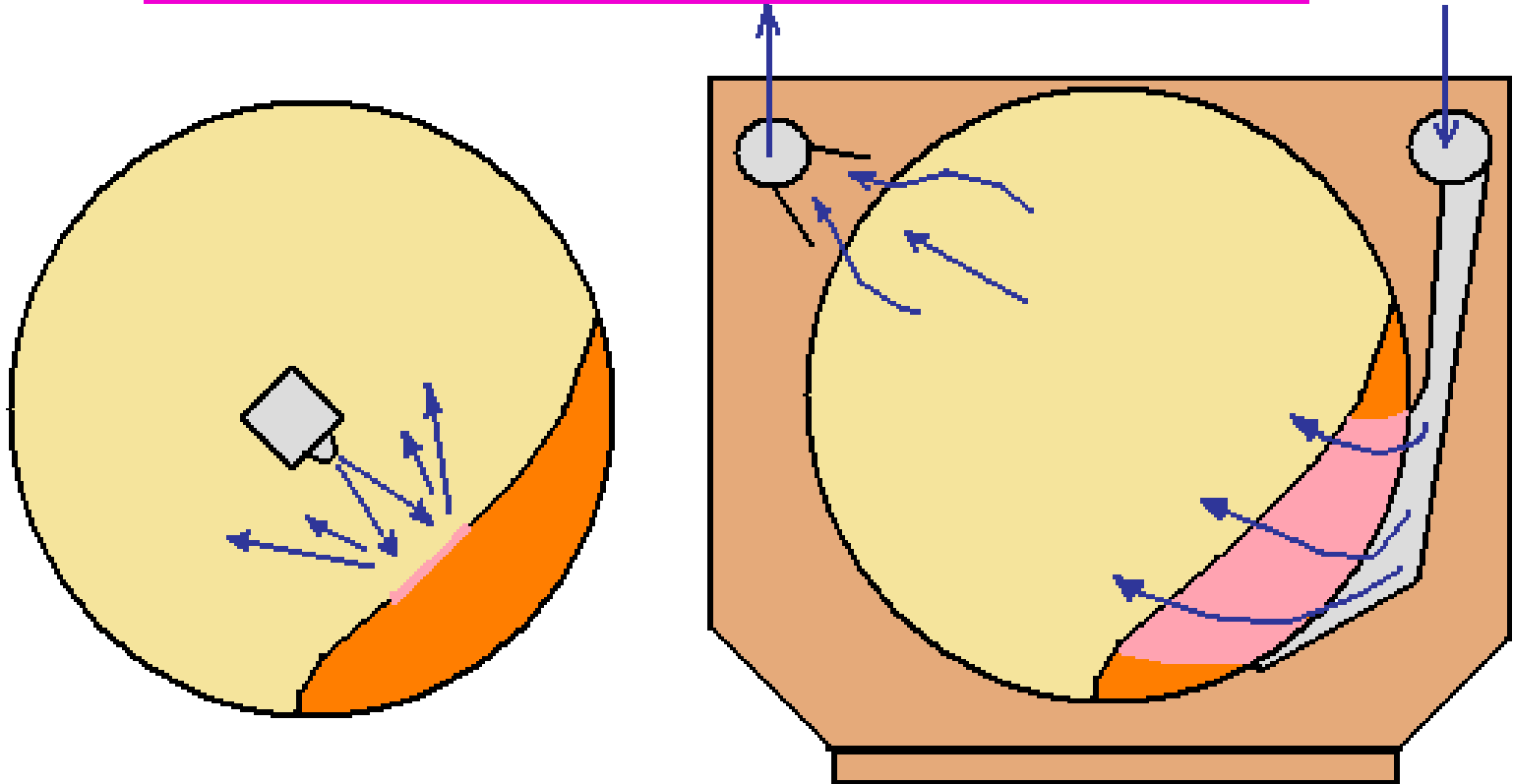
- The pan air flow effects drying efficiency of the coating pan and the uniformity of the coatings.
- High inlet air flow increases drying efficiency of sugar coating process and decreases in water penetration into the core.
- Excessive air flow may affect the sugar crystal structure (too big crystal) and then the crunchiness of the sugar shell.

PAN SPEED

- Increasing rotating speed of the pan improves mixing of the cores.
- The pan speed effects the time the cores spend on the spraying zone and subsequently, the homogenous distribution of the coating solution on the surface of each core throughout the batch.
- Increasing the pan speed decreases thickness variation and improves the uniformity of the coating.
- Too rapid rotating speed of the pan will cause the core abrasion and breakage.

DRYING METHOD

SOLID OR PERFORATED PAN

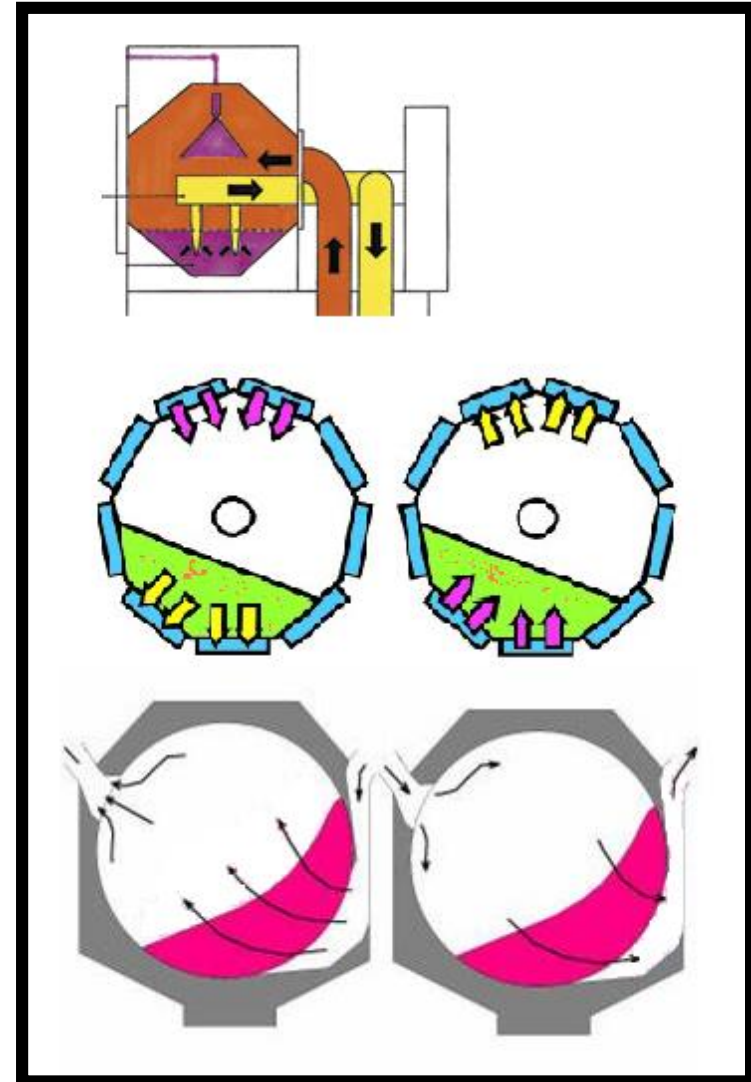


PERFORATED PAN DESIGN

PAN (Drum) Construction

a) Solid Pans

b) Perforated Pans



CHOCOLATE COATING

QUICK NOTE ON CHOCOLATE DEFINITION

- **Chocolate** is a raw or processed food produced from the seed of the tropical *Theobroma cacao* tree. Cacao has been cultivated for at least three millennia in Mexico, Central America and Northern South America. The seeds of the cacao tree have an intense bitter taste, and must be fermented to develop the flavor.



CHOCOLATE DEFINITION

- After fermentation, the beans are dried, then cleaned, and then roasted, and the shell is removed to produce cacao nibs. The nibs are then ground to cocoa mass, pure chocolate in rough form. Because this cocoa mass usually is liquefied then molded with or without other ingredients, it is called chocolate liquor. The liquor also may be processed into two components: cocoa solids and cocoa butter.

CHOCOLATE DEFINITION

Much of the chocolate consumed today is in the form of sweet chocolate, combining cocoa solids, cocoa butter or other fat, and sugar. Milk chocolate is sweet chocolate that additionally contains milk powder or condensed milk. White chocolate contains cocoa butter, sugar, and milk but no cocoa solids.



CHOCOLATE DEFINITION

- Cocoa solids contain alkaloids such as theobromine and phenethylamine, which have physiological effects on the body. It has been linked to serotonin levels in the brain. Some research found that chocolate, eaten in moderation, can lower blood pressure. The presence of theobromine renders chocolate toxic to some animals, especially dogs and cats.

CHOCOLATE DEFINITION (TEMPERING)

- The final process is called *tempering*. Uncontrolled crystallization of cocoa butter typically results in crystals of varying size, some or all large enough to be clearly seen with the naked eye. This causes the surface of the chocolate to appear mottled and matte, and causes the chocolate to crumble rather than snap when broken. The uniform sheen and crisp bite of properly processed chocolate are the result of consistently small cocoa butter crystals produced by the tempering process.

CHOCOLATE DEFINITION (TEMPERING)

- The fats in cocoa butter can crystallize in six different forms (polymorphous crystallization). The primary purpose of tempering is to assure that only the best form is present. The six different crystal forms have different properties.

Crystal	Melting temp.	Notes
I	17 °C (63 °F)	Soft, crumbly, melts too easily
II	21 °C (70 °F)	Soft, crumbly, melts too easily
III	26 °C (79 °F)	Firm, poor snap, melts too easily
IV	28 °C (82 °F)	Firm, good snap, melts too easily
V	34 °C (93 °F)	Glossy, firm, best snap, melts near body temperature (37 °C)
VI	36 °C (97 °F)	Hard, takes weeks to form

CHOCOLATE DEFINITION (TEMPERING)

- Making chocolate considered "good" is about forming as many type V crystals as possible. This provides the best appearance and texture and creates the most stable crystals, so the texture and appearance will not degrade over time. To accomplish this, the temperature is carefully manipulated during the crystallization.

CHOCOLATE DEFINITION (TEMPERING)

- Generally, the chocolate is first heated to 45 °C (113 °F) to melt all six forms of crystals. Next, the chocolate is cooled to about 27 °C (81 °F), which will allow crystal types IV and V to form. At this temperature, the chocolate is agitated to create many small crystal "seeds" which will serve as nuclei to create small crystals in the chocolate. The chocolate is then heated to about 31 °C (88 °F) to eliminate any type IV crystals, leaving just type V. After this point, any excessive heating of the chocolate will destroy the temper and this process will have to be repeated.

CHOCOLATE DEFINITION (TEMPERING)

- As a matter of fact, tempered chocolate is not used in chocolate coating. The chocolate will actually self temper due to the continuous rubbing from product to product during coating. The chocolate will not be shiny at the end of the process (like the back of a chocolate plate). The chocolated products are usually polished then varnished or sugar coated. Giving them
 - a better heat resistance (not melting in fingers),
 - High glossy effect
 - Allow to pack them in bulk (without scaffing)

WATERPROOFING OR SEALING

- Most centers used for coating are stable enough to survive the coating unharmed. For this reason, it's only necessary to stabilize the centers in few cases.
- The main reason is highly moisture sensitive products, fat migration or specific roughness. Then prior sealing is required.

- Varnish
 - Resin
 - Gum
- |—— Dissolved in a solvent

Some cores are sticky (and can't be stored prior to coating), some are not stable (volume variation or crystallization not finished, some could be too soft for being coated)

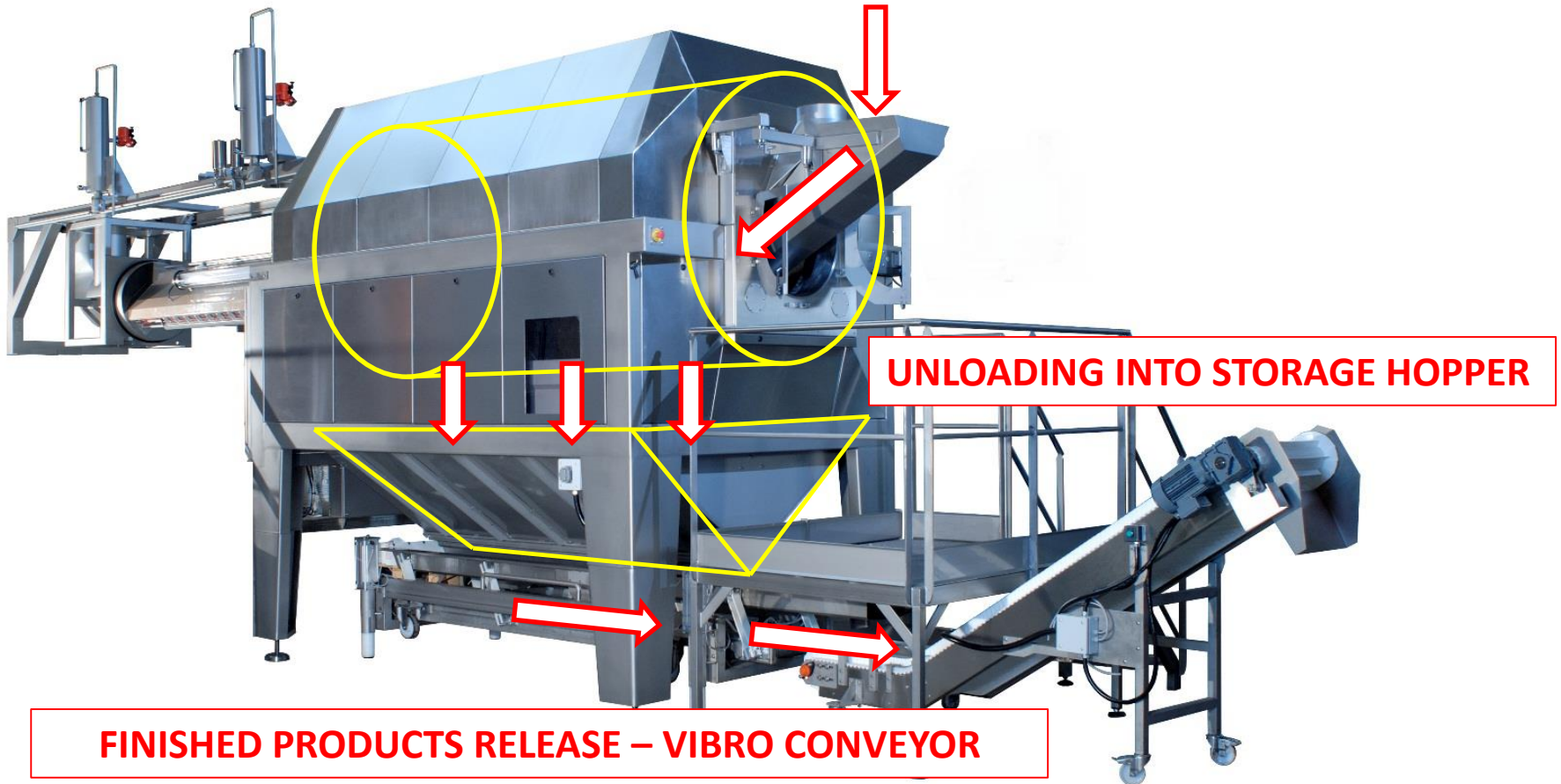
EQUIPMENTS FOR COATING INSTALLATION

AUTOMATIC COATING INSTALLATION

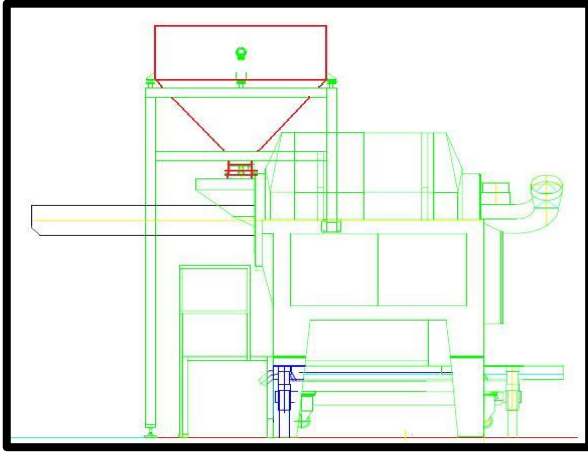
- COATING PAN WITH LOADING AND UNLOADING
- SYRUP / CHOCOLATE DOSING AND SPRAYING
- DRY POWDER DOSING AND SPRAYING
- CARNAUBA WAX / VARNISH DOSING AND SPRAYING
- VENTILATION SYSTEM
- CONTROL SYSTEM

COATING PAN: PRODUCTS FLOW

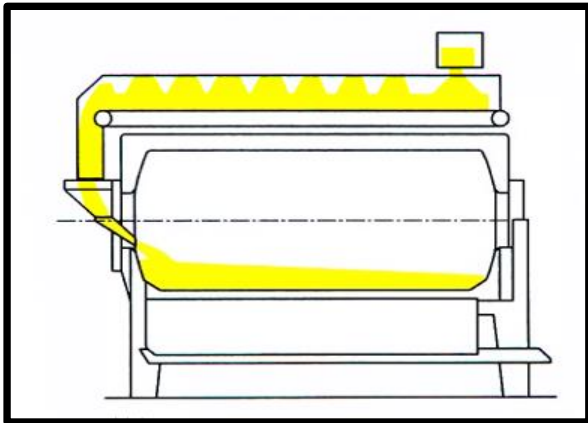
LOADING FROM FRONT



PRODUCTS LOADING



STORAGE LOADING HOPPER For strong products



STORAGE LOADING CONVEYOR For soft or brittle centers



CENTERS LOADING

HORIZONTAL STORAGE BELT ON TOP OF THE PAN

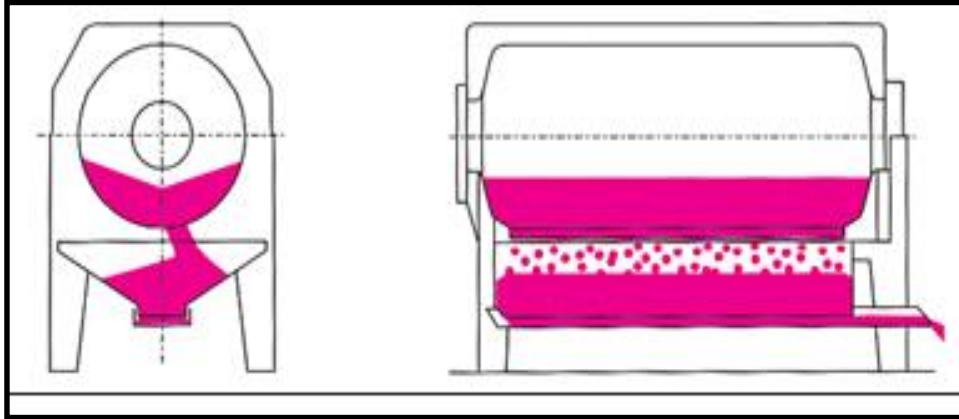


**Preferred solution
for fragile or
sticky centers**

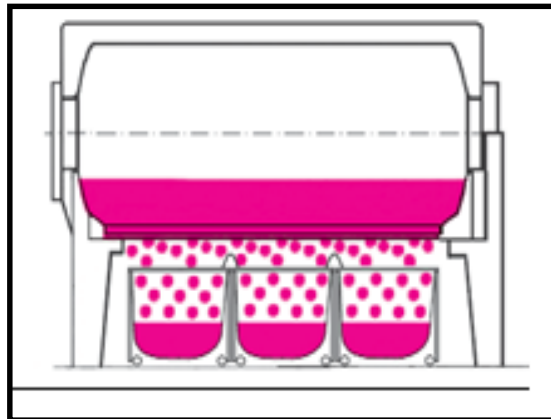
**Continuous feeding
from centers
production line**

**Machine loading
in few minutes**

FINISHED PRODUCTS UNLOADING



**UNLOADING HOPPER
+
VIBRATING CONVEYOR**



CONTAINERS

FINISHED PRODUCTS UNLOADING



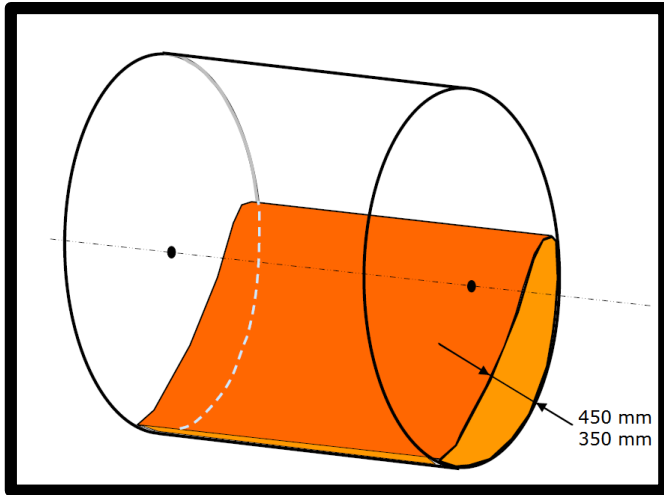
UNLOADING HOPPER + VIBRATING CONVEYOR

**Discharge of the complete batch
in 2 minutes**

→ Machine ready for next batch

**Slow release of the products with
vibrating conveyor, to feed
mixing or packaging line**

COATING PAN: DRUM DESIGN



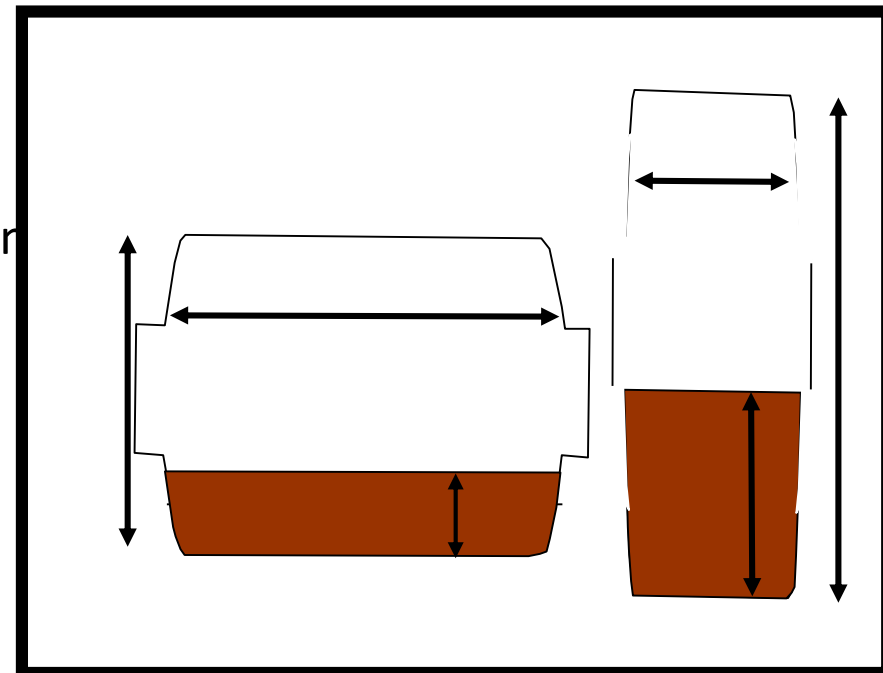
Design

Usually cylindrical, with rounded sides 3 key numbers, length, diameter, bed depth. we will spray and dry on a surface dictated by this 3 key numbers. In a cylindrical drum there's no natural movement to move the products from front to the back.

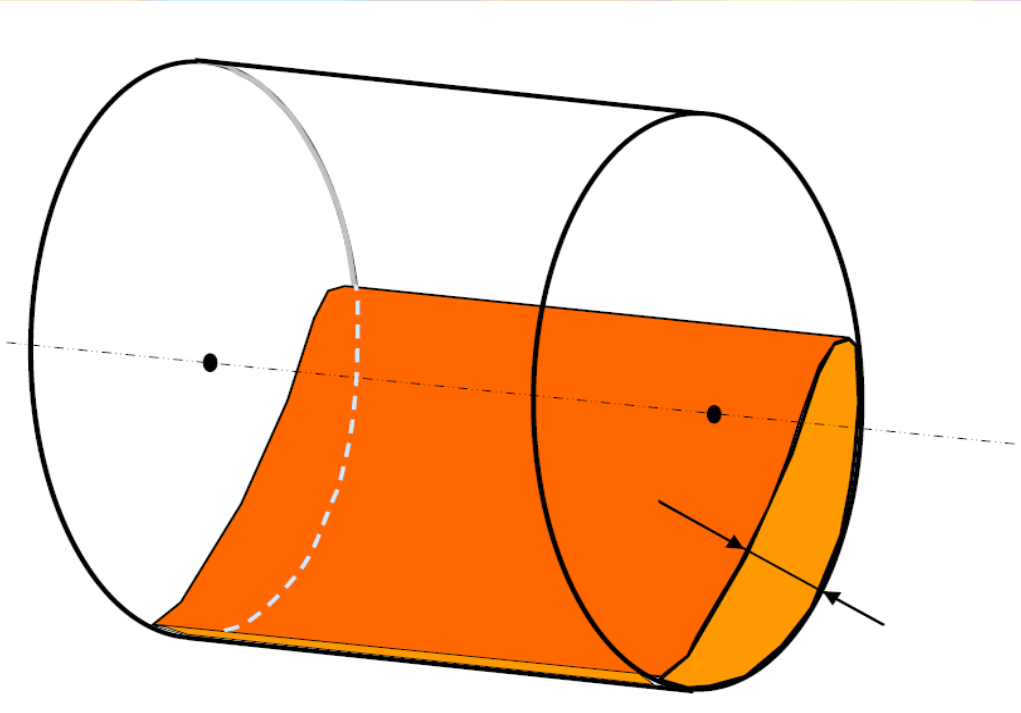
As Homogeneity will be a important factor for quality and process time, mixing baffles are a major factor in the pan design. Bed depth dimension is also critical as products can be deformed or be damaged by their own weight

Batch sizes

(250 to 3.000kg finished product)



COATING PAN: DRUM DESIGN



ELONGATED DRUM SHAPE

→ **LOW BED DEPTH**

250 kg	36 cm
500 kg	45 cm
1000 kg	45 cm
2000 kg	54 cm
3000 kg	63 cm

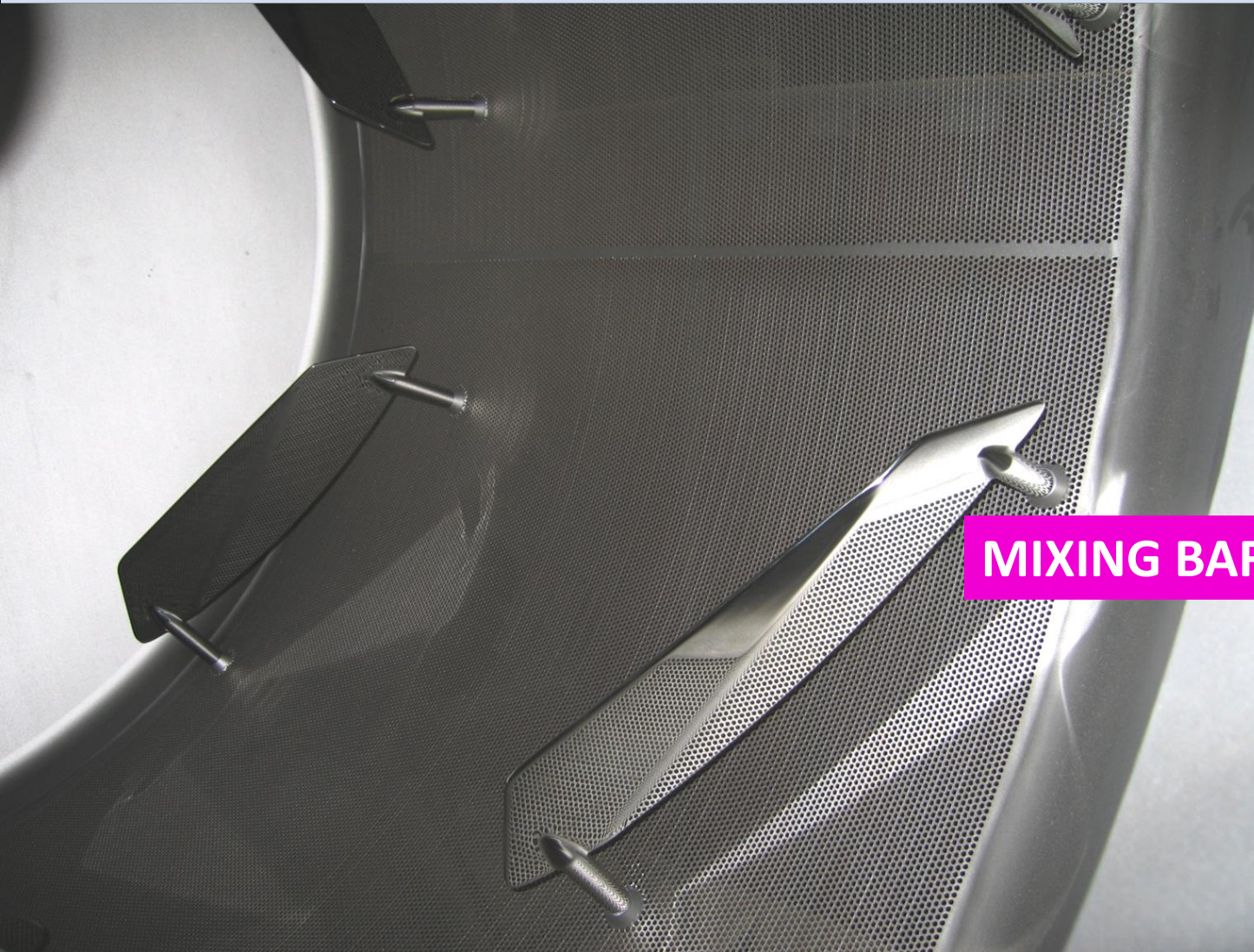
SUITABLE FOR FRAGILE PRODUCTS

WIDER EXPOSURE TO SPRAYING AND VENTILATION

BETTER HOMOGENEITY

BETTER MIXING

NECESSARY MIXING



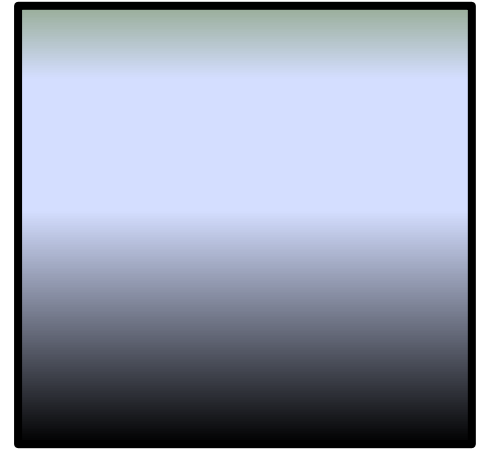
MIXING BAFFLES

COATING PAN: DRUM DESIGN

PAN (Drum) Construction

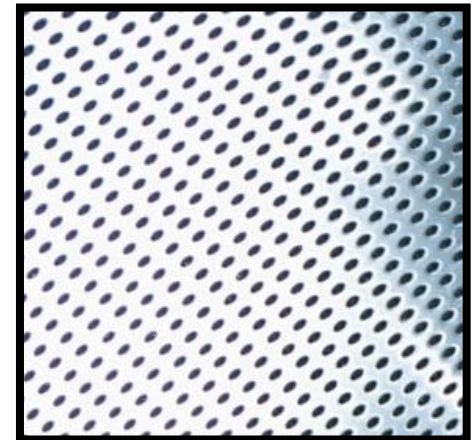
a) Solid Pans

- * Chocolate coating
- * Hard coating (Sugar and sugar free) **slow** process
- * Soft coating



b) Perforated Pans

- * Hard coating (Sugar and sugar free) **fast** process



AIR TREATMENT

CHOCOLATE



COLD AIR



SUGAR



DRY AIR

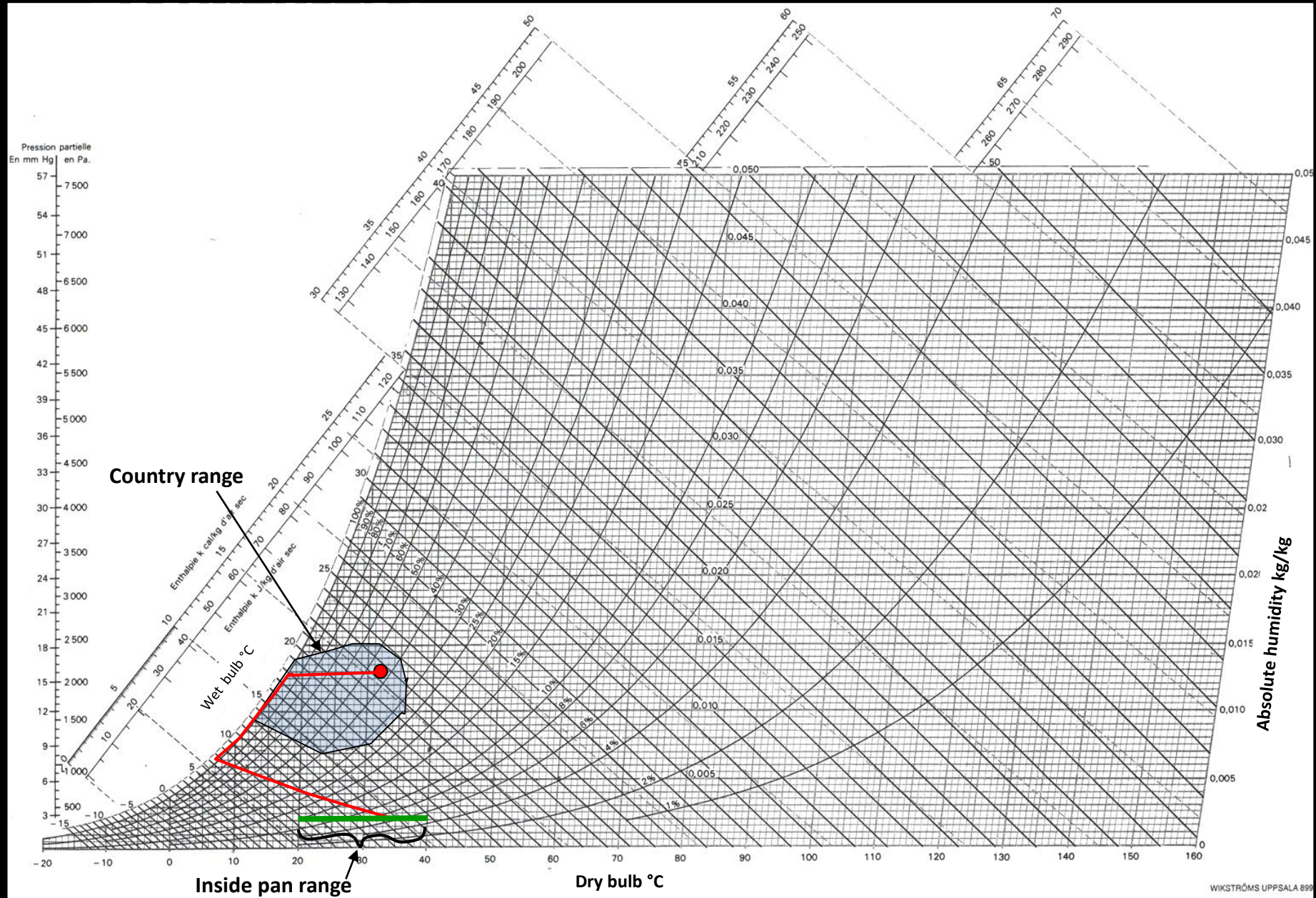


AIR TREATMENT

- 1. Some ideas about humidity**
- 2. Air Recirculation (chocolate)**
- 3. Standard dehumidification
(condensation)**
- 4. Desiccation**

Humidity – Definitions

- **Climatic Conditions**
- **Dew Point**
- **Absolute humidity**
- **Relative humidity**



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SUGAR COATING

Equipment and Process

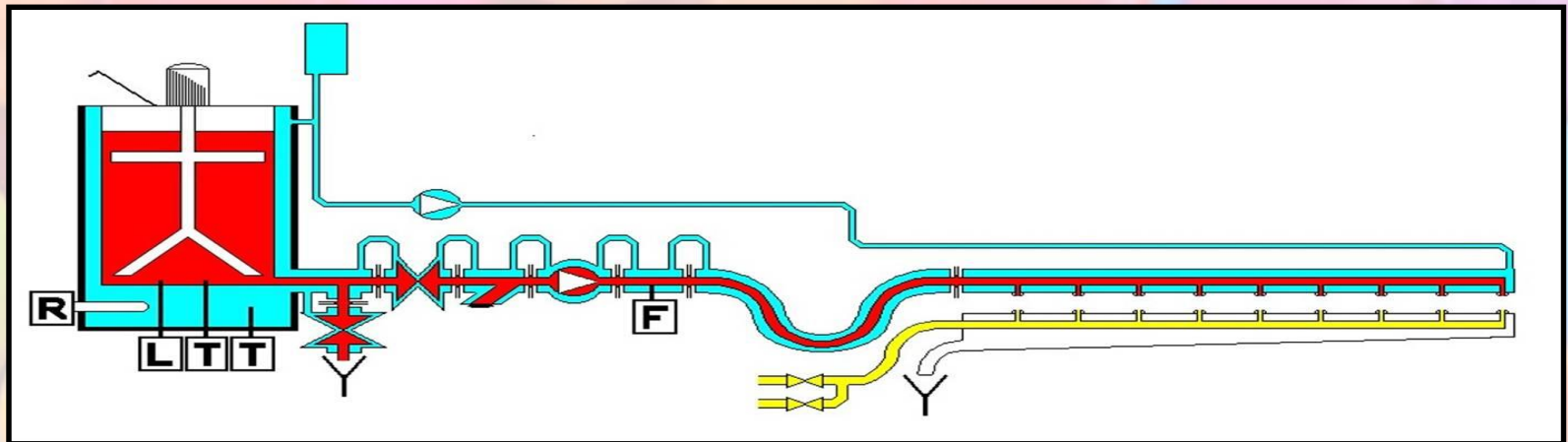
SUGAR COATING PAN: SPRAYING SYSTEMS



**FULLY EQUIPPED SPRAYING BAR
EXTRACTIBLE OUT OF THE PAN
WITH SPRAYING SYSTEMS
FOR SYRUP, POWDER, WAX**

DUMOULIN SYRUP SPRAYING SYSTEM: QUALITY AND ACCURACY

- STORAGE TANKS WITH TEMPERATURE CONTROL
- FREQUENCY CONTROLLED PUMP
- SYRUP FLOWMETER
- DOUBLE JACKETED SYRUP NETWORK
- SELF CLEANING SPRAY NOZZLES
- REPEATABILITY OF ALL PARAMETERS



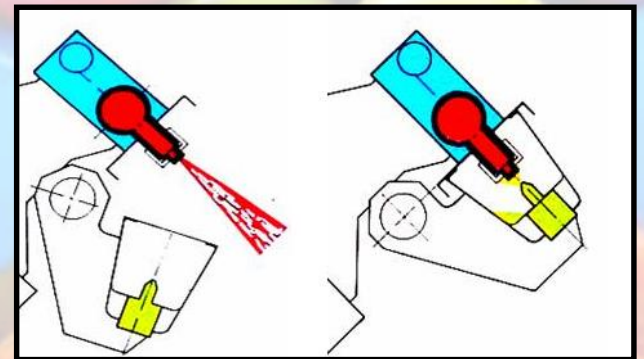
SYRUP SPRAYING SYSTEM



SELF CLEANING SPRAY NOZZLES

**AUTOMATIC HOT WATER
CLEANING AFTER EACH
SPRAYING STEP**

**NO CRYSTALLIZATION ON
TIP OF NOZZLES**



DUMOULIN WAXING /VARNISHING SYSTEM:

- WAX / VARNISH IS APPLIED DURING SAME BATCH,
NO CURING, NO HANDLING
- DRY POWDER DISTRIBUTION FOR CARNAUBA WAX
or
- AIR SPRAY GUNS FOR ALCOHOLIC VARNISH
- CONTROL AND REPEATABILITY OF ALL PARAMETERS

POWDER SPRAYING SYSTEM

ENGROSSING

Sugarfree

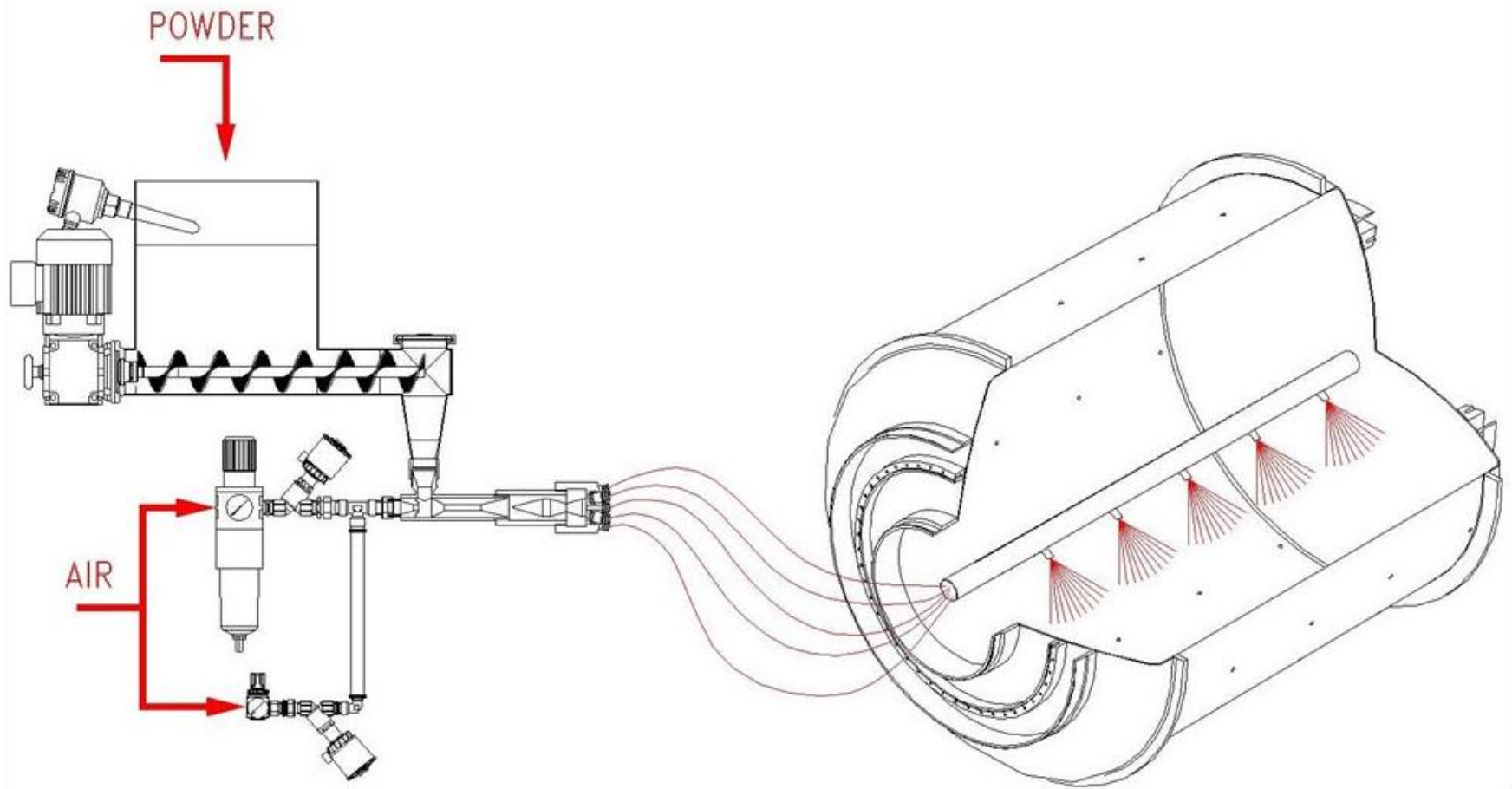


FINISHING LAYER

e.g. Icing sugar

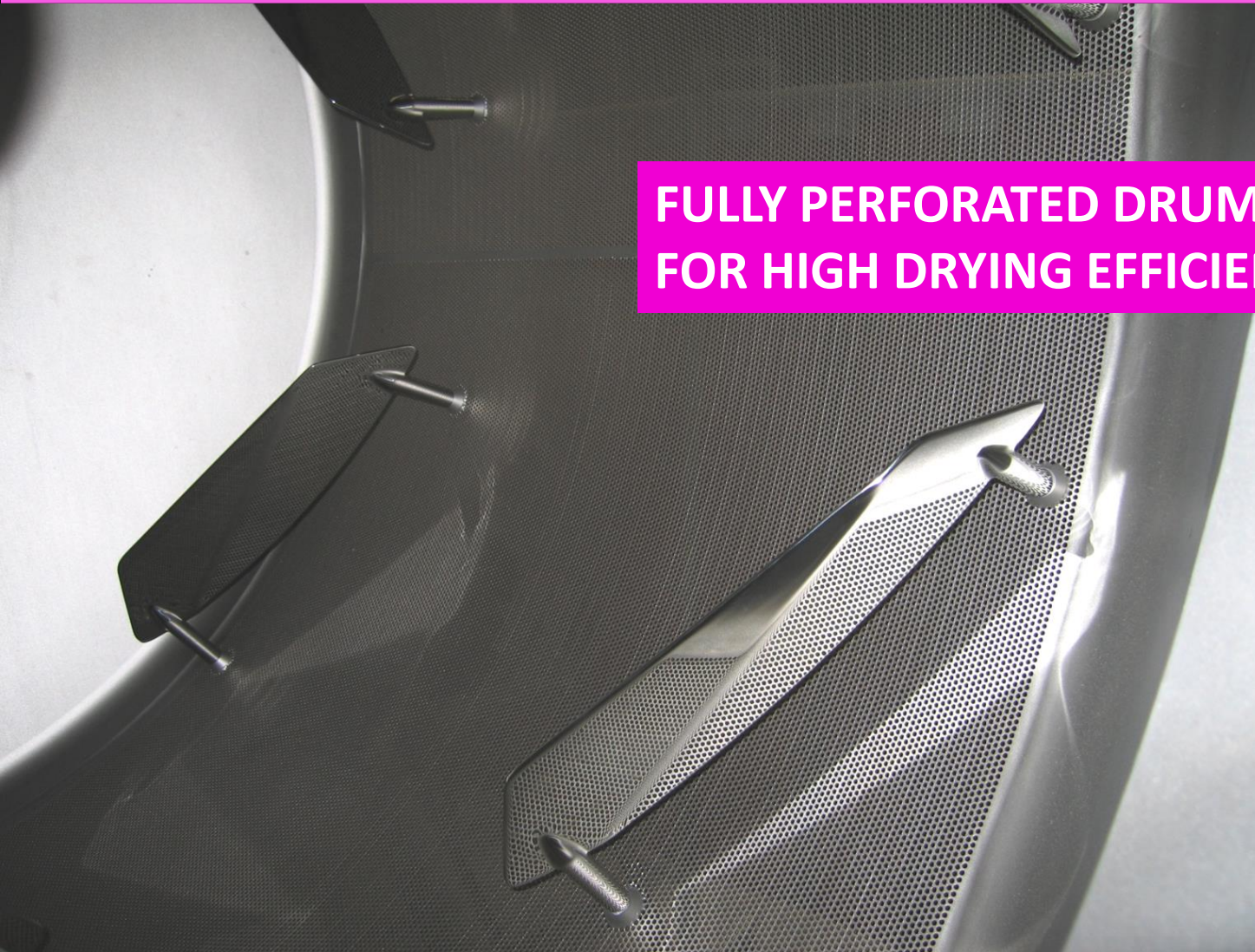


POWDER SPRAYING SYSTEM

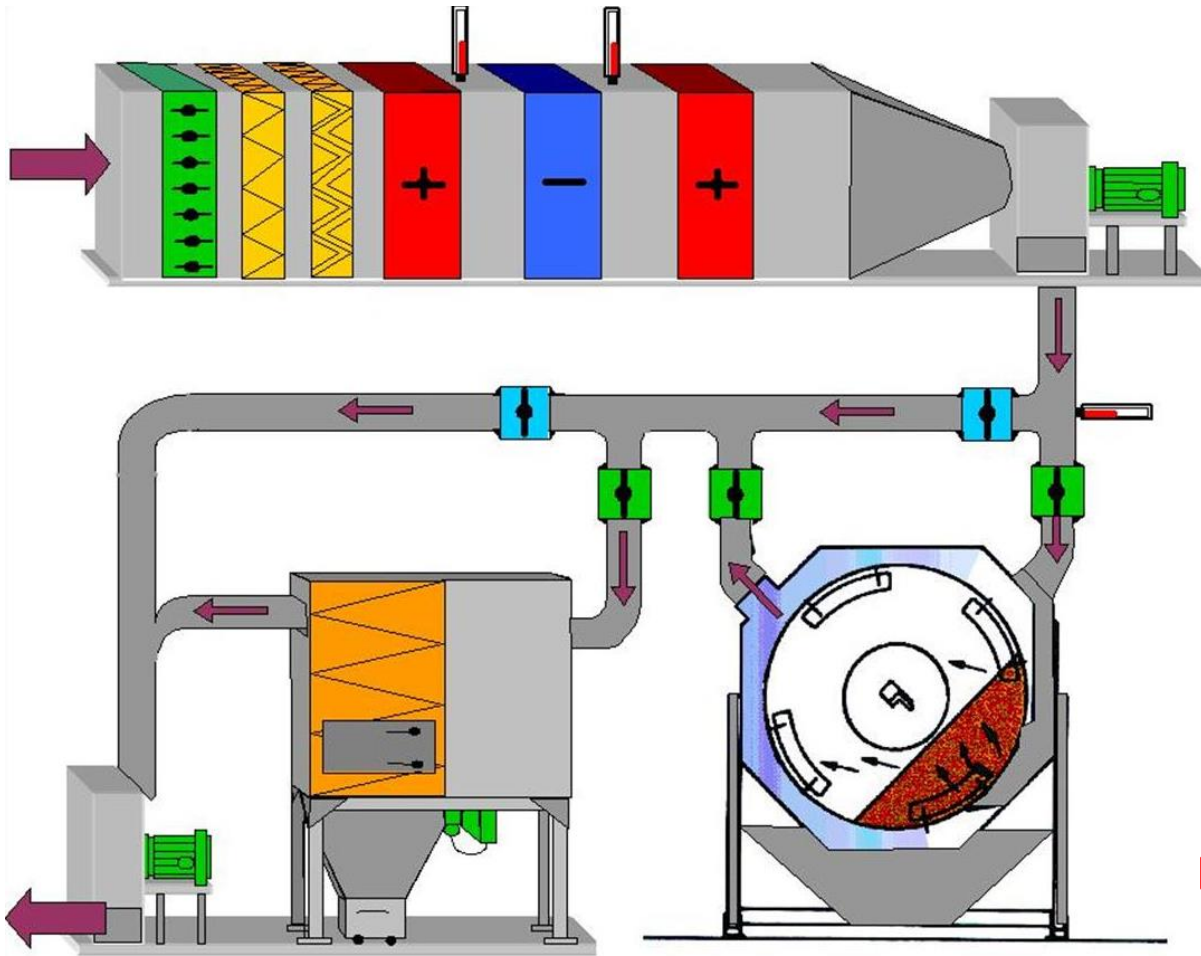


SUGAR COATING PAN: DRUM DESIGN

**FULLY PERFORATED DRUM
FOR HIGH DRYING EFFICIENCY**



VENTILATION SYSTEM



AIR CONDITIONING UNIT:
Filters, preheating,
Cooling, heating

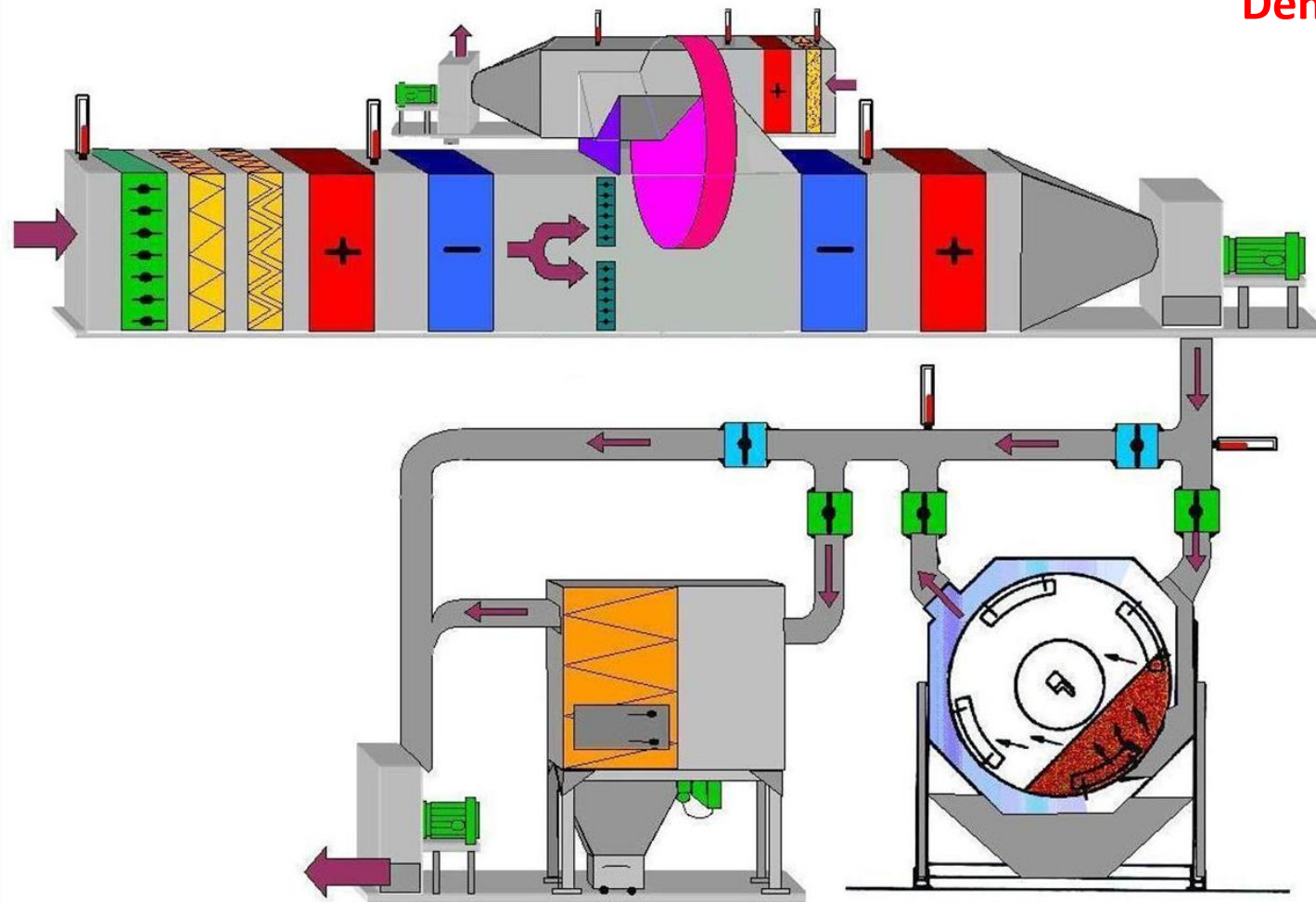
**BLOWING UNDERNEATH
PRODUCTS BED,
EXHAUST ON OPPOSITE SIDE**

DUST COLLECTOR

VENTILATION SYSTEM

Dehumidification Wheel

Alternative for
Sugarfree Coating



A close-up photograph of several dark chocolate-coated almonds. The almonds are round and have a glossy, reflective surface. They are arranged in a cluster, with some in the foreground and others slightly out of focus in the background. The lighting creates bright highlights on the smooth chocolate coating.

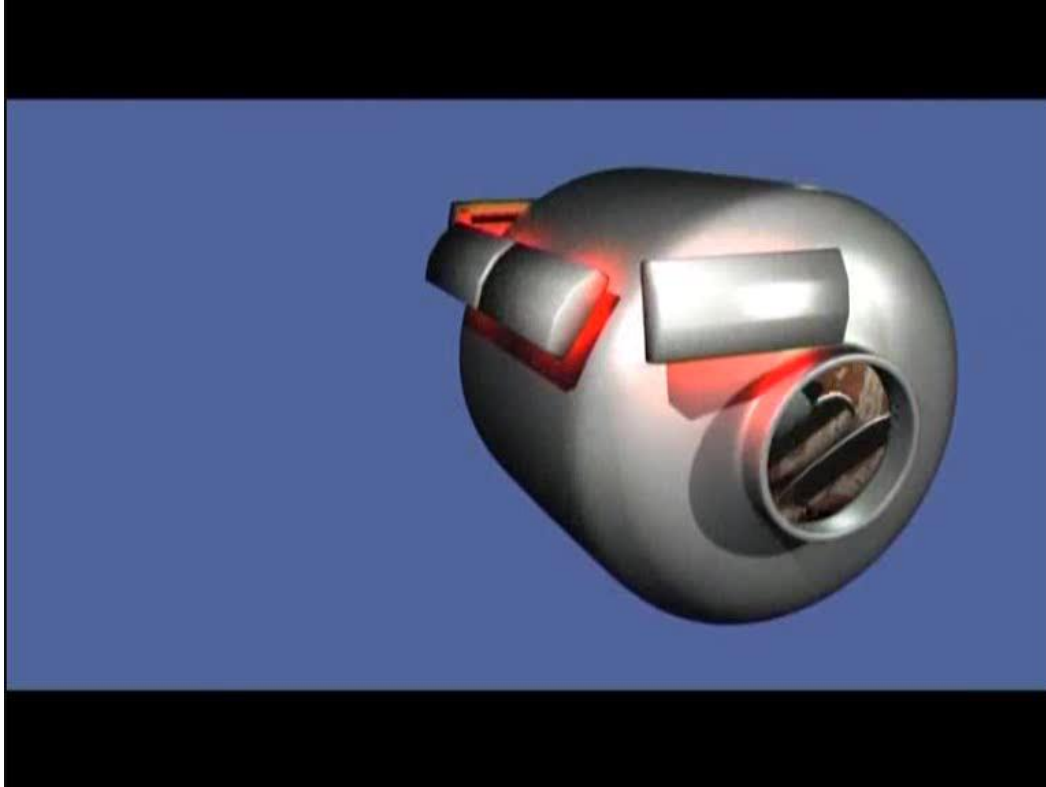
CHOCOLATE COATING

Equipment and Process

IDAC

Dumoulin

CHOCOLATE COATING PAN: DRUM DESIGN



INFRARED HEATING SYSTEM

TEMPERATURE CONTROL OF THE DRUM DURING PROCESS:
LESS CHOCOLATE STICKING ON DRUM WALL

CHOCOLATE RECOVERY AND CLEANING:
MELTING AND CLEANING WITH NEW CENTERS

CHOCOLATE COATING PAN: SPRAYING SYSTEMS



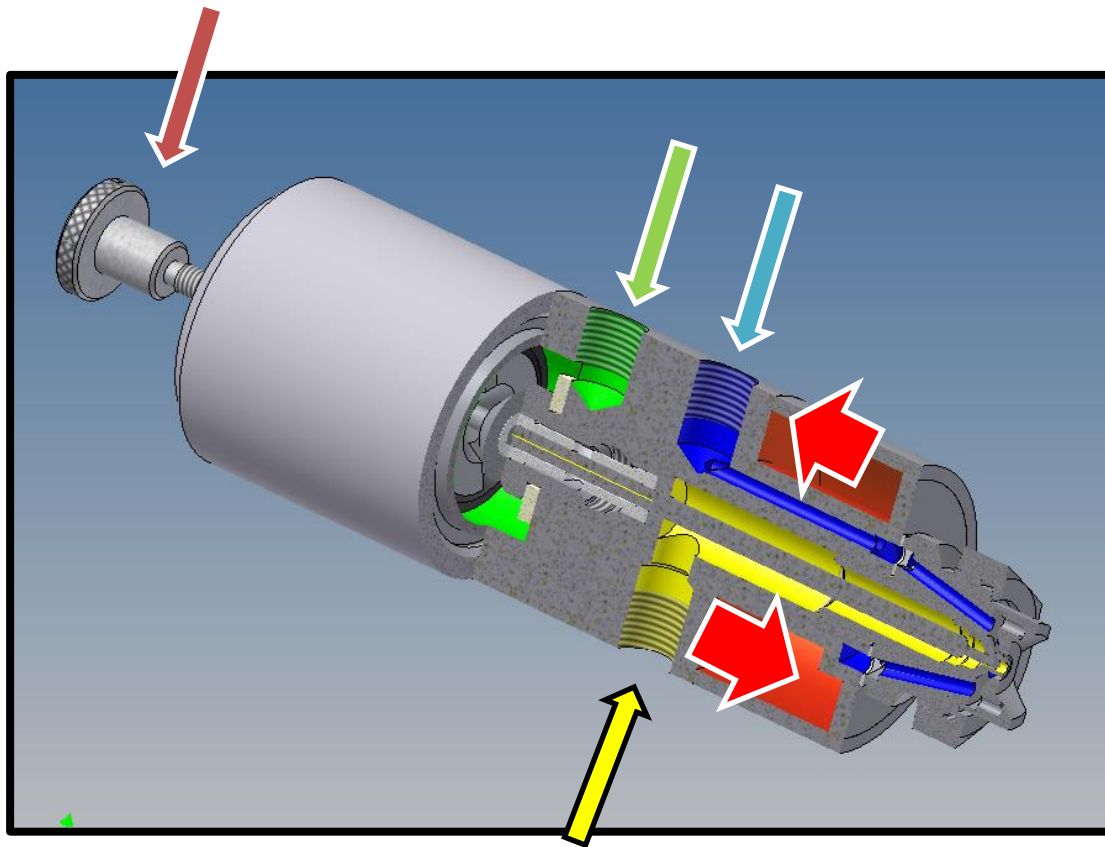
**FULLY EQUIPPED SPRAYING BAR
EXTRACTIBLE OUT OF THE PAN
WITH SPRAYING SYSTEMS FOR
CHOCOLATE, POLISH, VARNISH, DRY
INGREDIENTS**

DUMOULIN CHOCOLATE SPRAYING SYSTEM

QUALITY AND ACCURACY

- STORAGE TANKS WITH CONTROLLED TEMPERATURE
- HIGH PRESSURE PUMP
- FINE MECHANIC FILTER
- CHOCOLATE MASSIC FLOWMETER
- ADJUSTABLE ATOMIZATION CHOCOLATE SPRAYING GUNS
 - CONTROL OF CHOCOLATE DROPLETS SIZE
- CONTROL AND REPEATABILITY OF ALL PARAMETERS

CHOCOLATE SPRAYING SYSTEM



UNIQUE DESIGN ATOMIZATION GUN

CHOCOLATE LINE

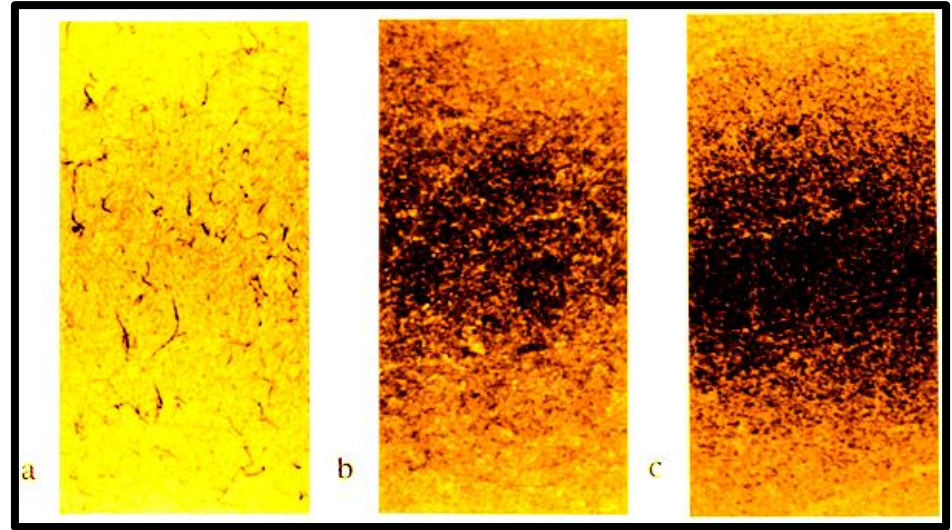
HOT WATER JACKET

COMMAND AIR

ATOMIZATION AIR

INDIVIDUAL CHOCOLATE
FLOW ADJUSTMENT

CHOCOLATE SPRAYING PATTERN



ADJUSTABLE ATOMIZATION PRESSURE

→ VERY FAST BUILDING

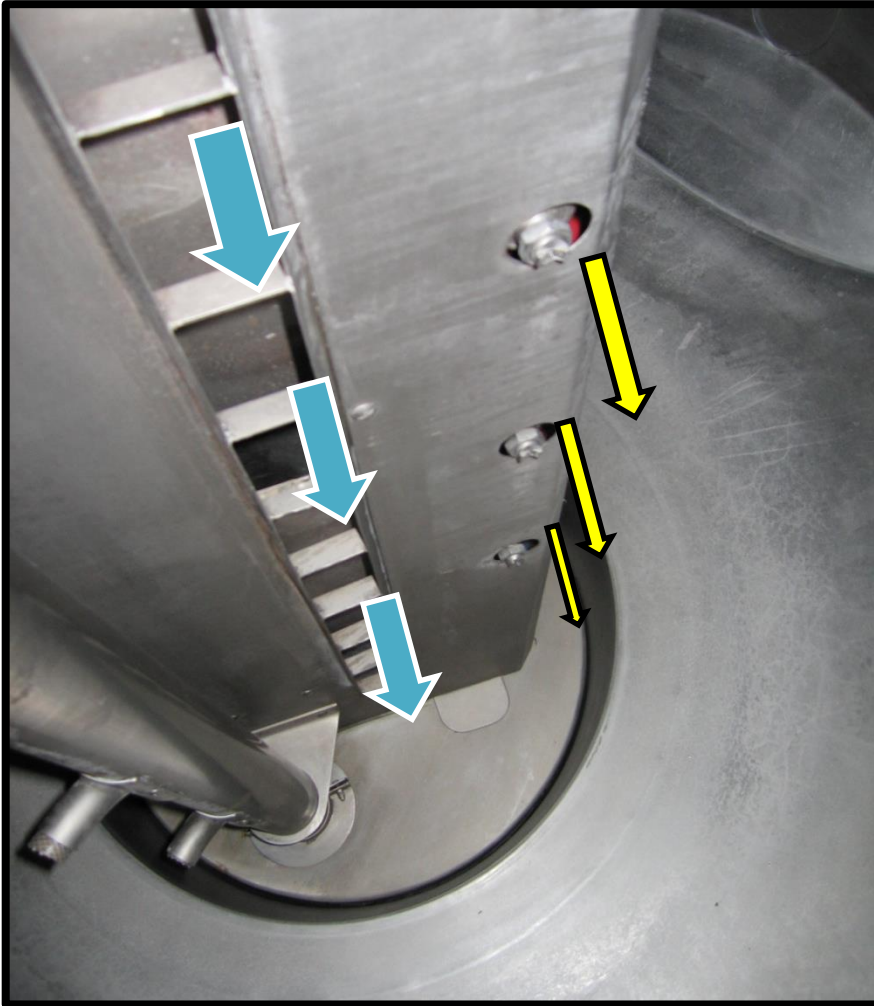
FULL COVERAGE (especially for difficult shape)

REDUCTION OF DOUBLES

HOMOGENEITY



CHOCOLATE SPRAYING SYSTEM



FILM COATING PROCESS

→ VERY FAST BUILDING

BALANCE OF AIRFLOW
AND AIR TEMPERATURE
TOGETHER WITH FLOW OF
CHOCOLATE

FINISHING

OVERWETTING AND SPREADING
AT END OF THE BATCH
FOR SMOOTHING

DUAL CHOCOLATE SPRAYING SYSTEM



BI-COLORS COATING
TWO LAYERS IN SAME
PROCESS WITHOUT
CROSS MIXING
MARBELLING

POWDERING



DUMOULIN POLISH AND VARNISH SPRAYING SYSTEM

QUALITY AND ACCURACY

- ONE SPRAYING SYSTEM FOR POLISH AND ONE FOR VARNISH



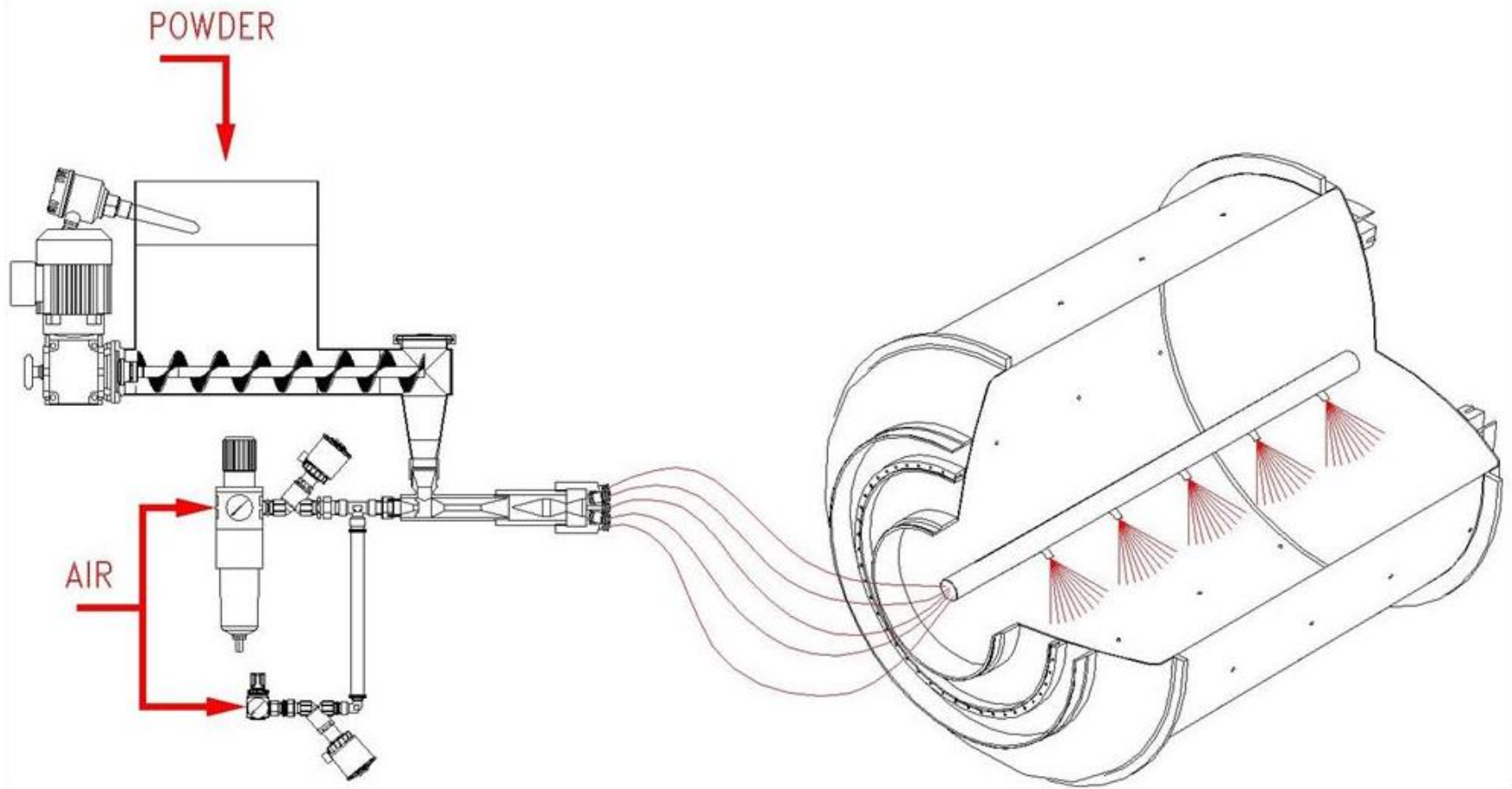
- STORAGE TANKS WITH MIXING
- PRESSURE PUMPS
- FLOWMETERS
- ADJUSTABLE ATOMIZATION SOLUTION SPRAYING GUNS
- CONTROL AND REPEATABILITY OF ALL PARAMETERS



DUMOULIN POLISH AND VARNISH SPRAYING SYSTEM

- **VARNISH IS APPLIED DURING SAME BATCH,
NO CURING, NO HANDLING**
- **AIR SPRAY GUNS FOR AQUEOUS POLISH (GUM)
1 to 3 LAYERS**
- **AIR SPRAY GUNS FOR ALCOHOLIC VARNISH (SHELLAC)
1 LAYER**
- **TOTAL VARNISHING TIME maxi. 1 HOUR**
- **CONTROL AND REPEATABILITY OF ALL PARAMETERS**

DRY INGREDIENTS SPRAYING SYSTEM



DRY INGREDIENTS SPRAYING SYSTEM

FINISHING LAYER

e.g. Icing sugar, Cocoa powder



INSIDE CHOCOLATE COATING

e.g. Nuts particles



VENTILATION SYSTEM

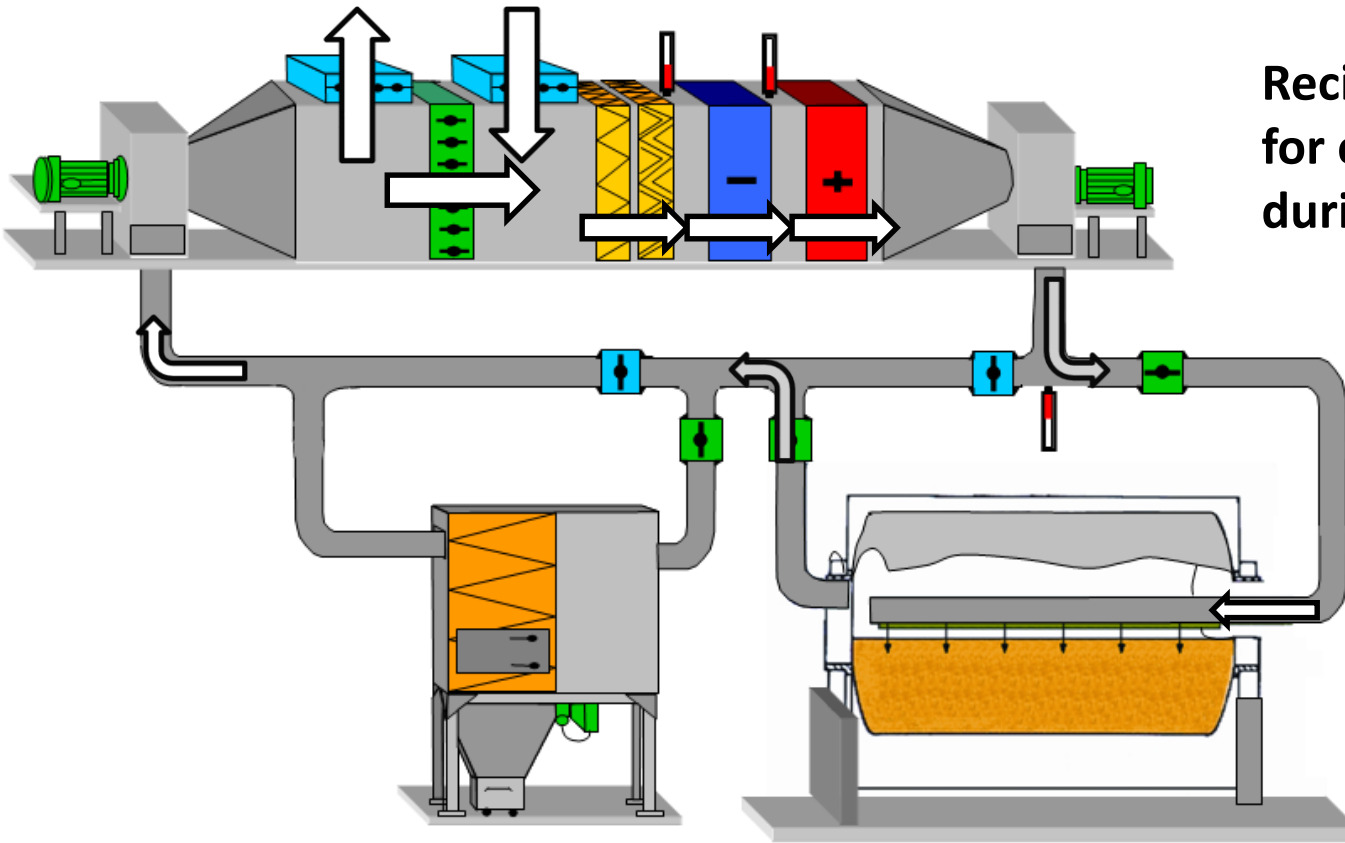
AIR CONDITIONING UNIT: Filters, Cooling coil, Heating coil

Recirculation
for energy saving
during chocolate coating

New air for cooler
outside
temperature, or
shellac application

DUST COLLECTOR

**FULLY ENCLOSED SYSTEM: MINIMAL CONSUMPTION
ALL ENERGY IS ONLY FOR THE PRODUCT**



COST ENERGY

kW.h/kg of finished products (Chilled water, steam, electricity, air compressed)	Dumoulin Automatic coating IDA 1002CV	Belt Coater chocolate + Belt coater varnish	Traditional pans (130 liters)
Finish product Bulk density	0,77	0,77	0,77
Volume per unit	1300	430	130
Productivity (kg/24H)	9 181	9 111	9 327
Nb of chocolate machines	1	3	11
Nb of Varnish machines	0	3	11
installed steam power (kW)	150	150	150
average steam power (kW)	31,25	75	150
installed chilled water power (kW)	140	140	140
average chilled water power (kW)	35	70	140
Installed electric (kW)	70	100	120
Average electric (kW)	35	50	60
Total kW equivalent electrical	84	169	280
Used kWh per day	2010	4056	6720
Cost of 1 kW.h in Europe (€)	0,10	0,10	0,10
Cost of one day energy	201	406	672
Cost per 1 kg of finished product in Euros (only energy)	0,02 €	0,04 €	0,07 €
Yearly Energy cost (Euros)	60 300 €	121 680 €	201 600 €
Loading (min)	5	15	15
1000 kg chocolate coated peanuts (50% chocolate coating) (kW.h)	50	75	135
Chocolate process time (min)	100	140	140
Unloading time (min)		2	15
Trays (min)		30	30
curing room (kW.h)		7	7
Trays cleaning (kW.h)		2	2
Loading for varnishing (min)		15	15
1000 kg Varnishing (kW.h)	25	100	100
Varnishing process time (min)	50	80	80
Unloading (min)	2	2	15
Required Operator	0,2	1	1

DUMOULIN CONTROL SYSTEM



**Panel PC with
15inch touch screen**

EASY TO OPERATE

CLEAR MACHINE DISPLAYS

**ETHERNET CONNECTION FOR
PRINTER, DATA LOGGING...**

90 RECIPES

PASSWORD PROTECTION

AUTOMATIC COATING TECHNOLOGY

SUGAR COATING RECIPE

Dumoulin	Mode : Auto Comms : ok	User ID : dumoulin	IDA 2002 X Coater		16/10/2009 14:39:32	Active Alarms
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Recipe

1

Fresh Mint

Editing Recipe Library

Step	Product	Rep.	Coater Speed 1	Spraying		Flavor	Spread 1	Powder	Spread 2
				Quant.	Flow				
1-15	Description	0-99	rpm	l	l/min	kg	sec.	kg	sec.
1	Syrup 10	1	7.0	13.0	20.0	0.7	0	0.0	0
2	Syrup 10	1	7.0	7.0	20.0	0.0	5	4.5	170
3	Syrup 10	4	6.0	8.0	20.0	0.0	5	3.5	170
4	Syrup 10	4	6.0	7.5	20.0	0.0	10	2.5	110
5	Syrup 10	7	6.0	9.0	22.0	0.0	20	0.0	0
6	Syrup 10	8	6.0	10.0	22.0	0.0	40	0.0	0
7	Syrup 10	4	6.0	20.0	25.0	0.2	40	0.0	0
8	Syrup 10	11	6.0	18.0	25.0	0.2	30	0.0	0
9	Syrup 10	5	6.0	14.0	24.0	0.2	30	0.0	0
10	Syrup 10	5	6.0	7.5	15.0	0.0	30	0.0	0
11	Wax	1	6.0	200.0	0.0	0.0	0	0.0	0
12	Wax	3	6.0	0.0	0.0	0.0	0	0.0	0
13		0	0.0	0.0	0.0	0.0	0	0.0	0
14		0	0.0	0.0	0.0	0.0	0	0.0	0
15		0	0.0	0.0	0.0	0.0	0	0.0	0

1=Syrup 12, 2=Syrup 11, 3=Syrup 10, 4=Wax, 5=Gelatine

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Summary

Recipe Library	Command	Production	Air	Coater	Syrup	Powder	Washing	Trends	Utilities
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COMMISSIONING

- Automation and Process engineers for :
 - . Checking assembly
 - . Start Up
 - . Process development and optimisation
 - . Training (Operators, Maintenance, R&D)

