TUNNEL RACK OVEN SYSTEM

DIJKO MOVES THE AIR

dijko®

OVENS - MACHINES

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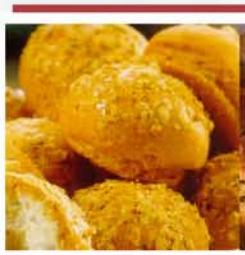


CONTENTS

THE FULLY AUTOMATIC
DIJKO - TUNNEL RACK BAKING SYSTEM




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GENERAL DESCRIPTION

The Dijko Tunnel Rack Baking System is unique. It has been specially designed for use in bread and confectionery bakeries where products may be baked on trays or in tins. The system is suitable for producing a wide range of products including the many varieties of bread, pizzas, pies, biscuits and a full range of cakes, cookies and pastries where automatic handling through many of the proving, baking and cooling stages will be economically beneficial. A system can, depending on the product, consist of: Prover, Oven, Cooler and Freezer Modules. Optionally, an Inspection (used after the Prover and Oven Modules) and U-Transporter Module with optional return conveyor (for a continuous Tunnel Rack Oven System) can be supplied. Additional products include a Loading/Unloading System or a Robot for automatic loading and unloading of the racks.

3D drawing: fully automatic Dijko oven system

A system for bread rolls and fermented goods would normally require prover, steaming, baking and cooling modules whereas pies, tarts and cake making operations would require only the baking, inspection and cooling. Mixed production can be accommodated within the full system.

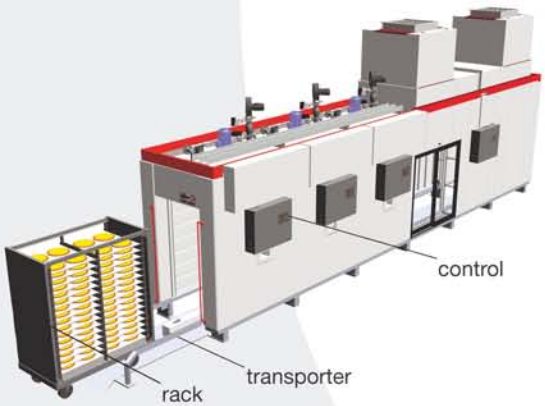
The Tunnel Rack Oven System is of modular construction. Appropriate modules can be supplied for most required production capacities and, if necessary, extra modules can be added at a later date.

MODE OF OPERATION

Baking trays are placed in special racks, with insulated front, back and base panels. These racks are automatically transported through the system. There is minimal use of floor space, often as little as 20% of that required for a conventional travelling oven of similar output, and so the investment in plant and buildings is significantly lower.

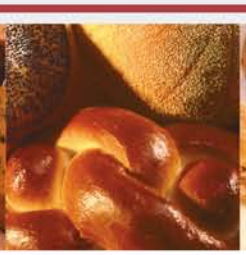
A timer to which an audible alarm is fitted controls transportation of the racks through the modular system. The timer is set after calculating the rack throughput rate, dividing the baking time by the number of oven modules and this indicates the intervals at which a fresh rack is drawn into the system. The oven is brought up to temperature within a very short time, normally ten minutes. Operations are started with unloaded racks already in the system and a loaded rack at the entry point. This rack is automatically drawn in as soon as the timer is started, with simultaneous discharge of a rack from the cooler. A second loaded rack should be prepared in time for the cycle. A warning buzzer will sound if there is no rack ready.

At the end of a baking shift, empty racks are used to clear the last of the full racks through the oven and so recharge the system ready to start again.



3D drawing: rack - transporter - control



OVEN RACKS

The standard racks can have lengths of 1.20, 1.60, 1.70, 1.90 and 2.00 metres. Methods to calculate the number of trays per rack are provided in later pages of this brochure.

The racks are built with rigid self-supporting frameworks as shown in the rack drawing below. They are normally made in aluminium coated sheet steel, but can also be supplied fabricated from stainless steel as an optional extra. It is advised to order a few more racks than the number of Modules in the system.

The base of the rack is particularly strongly made, ensuring both trouble free operation and long life. They are equipped with large diameter heavy-duty wheels with rubber tyres, to give smooth and silent movement. The wheels, being below the rack, do not enter the heated tunnel or need to be made of steel, which damage the floor and are noisy.

3D drawing: rack

At either end, the insulated panels seal against each oven module entry and exit framework and so prevent heat loss. There are support rails within the rack for each individual tray, which are accessible from the side.

In some circumstances, an automatic loading and unloading device can be supplied which when used on, say, roll plants; can provide a fully automatic system.

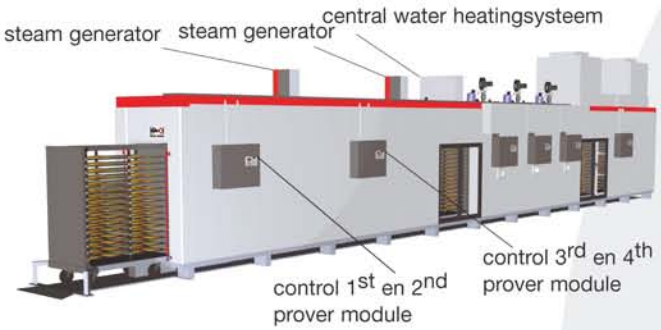
STANDARD PROVER MODULES

Automatic transport of the racks into the prover is initiated from the control panel on the first oven module, which controls operation through to the end of the oven. A PLC or control console for the whole Dijko Tunnel Rack Oven System can be provided if preferred, as an optional extra.

The heating and steaming arrangements are the same for all the prover modules, with temperature and humidity levels being controlled by digital instrumentation and a fan in each module providing the ideal mix and balance of heat and humidity as pre-determined by the instrument settings.

Condensate drainage is provided in the side panels of the prover. All modules are made from stainless steel.

Gas, oil or electricity may be chosen to provide heating for the prover. A hot water central heating system is installed for this purpose. Electricity is used for a steam generator but, if preferred, the prover can be connected direct to existing steam and heating systems.



3D drawing: standard prover line

MULTI-LANE PROVER

For bakeries which need additional throughput, a high capacity prover system can be supplied with lines of prover modules erected side by side to provide parallel tracks. A detailed layout will be provided to suit client requirements. The 'U' configuration drawing below illustrates how three prover lanes can be merged into a single oven lane lying parallel to and travelling in the opposite direction by use of a cross transporter system for racks.

The whole unit is made of double wall corrosion resistant material with six centimetres (2 3/8 inch) insulation between. The height of the prover modules matches the oven tunnel height. Each line of racks has its own motorised transportation mechanism with catch bars on the bottom of each rack and is controlled by the Programmed Logical Controller (PLC) for the full transport system. The multi-lane prover is designed to operate on a FIFO (First in First Out) principle. Manual positioning of the racks at the prover entrance of the first module is monitored by the PLC.

Picture: multi-lane prover

Very accurately controlled heat and humidity distribution is provided to each rack as it passes through the prover. The warm and moisten air is streamed across and through the prover, in one direction across the first module and redirected in reverse direction through the second module. Each module has its own heating and humidity control with digital instrumentation to allow different settings to be used in each section for the proving process required.

Control panels may be mounted on the prover modules themselves or again included in a central control console. Entry points for main supplies are located on the top of the prover system.

U-TRANSPORTER MODULE

This unit is an option that allows the prover, oven and cooler sections to be placed side by side.

The more common reasons for this are either because of insufficient length in the baking area for the units to be placed in line, or because there is a requirement for the racks to be returned to the prover or oven entry point automatically.

The U-transporter takes each rack from the oven, transfers it sideways then travelling in the reverse direction through the cooler parallel to the oven. It also acts as an inspection module with access to the products available through sliding doors.

As the racks are moved across the oven to the cooler, they are picked up by the 'U' section mechanism, which is independently driven by a chain drive arrangement. The transporter base and outside plating is made of stainless steel.

The operation of the transporter is controlled by the PLC and fully integrated with the rest of the tunnel rack oven system. Safety and warning devices are included to cover the possibility of a stoppage.

Picture: U-Transporter module

OVEN MODULES

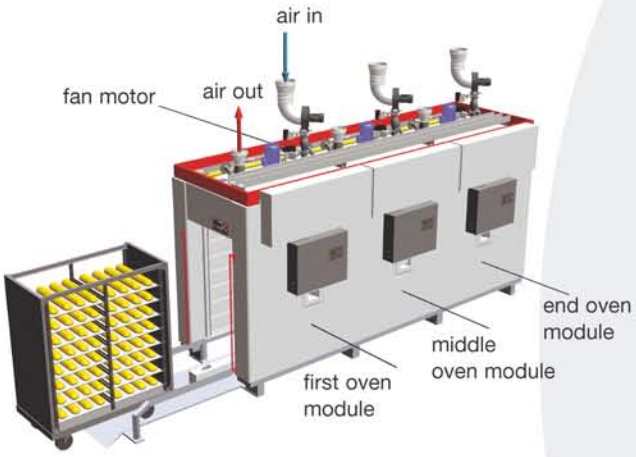
The oven is the heart of the Dijko Tunnel Rack Baking System and its excellence is the result of many years experience of baking a wide range of products.

A minimum of two oven modules is required in any baking system arrangement. (For smaller operations the Dijko Single Rack Oven or Tray Deck Oven can be supplied).

Each module within the oven takes one rack; the number of oven modules is being determined by throughput calculations for oven utilisation.

By using modern technology and sheet metal fabrication, the oven construction avoids the need for a rigid frame and comprises a stainless steel outer skin with an inner skin of aluminium coated sheet steel, which is rust proof and provides high heat reflection values. Between these is a 15cm (5 7/8") filling of high quality insulation, which provides a very cool exterior surface to the oven. All joints on the inner steel skin are welded.

Spring loaded metal pressure strips are fitted between each process change in the system. These ensure temperature differentials that can be maintained between the modules.



3D drawing: oven modules

Heating can be provided by gas, electricity or oil. In the case of gas or oil firing, heat exchangers are provided. Each module has its own heating and temperature controls so that by the use of different temperature zones, products such as cakes which may need increasing or decreasing temperature gradients during the baking operation, present no problems.

Stone flooring and other heat absorbing materials are not used, so initial heating-up time is very short and usually under ten minutes. As the heating and circulation system are in the top of each oven module they are readily accessible. Each oven module is a separate unit complete with its own fan, heating system, safety devices and controls which not only allow a range of temperatures to be used through the oven, but also reduce the installation time as the pre-assembled and tested units only need to be bolted together and sealed tight.

Picture: oven heating with gas

The oven can be provided with its own PLC control panel on the side, or a separate control console can be employed. Optionally, a scada system can be supplied to control and register the system.

OPTIONS

The Oven Modules can be outfitted with the following extras:

- PLC Control for all functions, with indication of all settings and process values + fault indication.

- Humidity Control on the PLC. The value of the desired humidity in the oven can be set. The damper will automatically open or close according to the required setting, and will keep the humidity within range. When the humidity is too low, a smaller valve can be opened to add steam into the module.

- Air Speed control of the recirculation fan with a frequency inverter, controlled by a PLC.

- Fully Stainless Steel of exterior and interior of the modules.

- Inspection windows with lighting can be added on the side of the oven, to monitor the progress of the baking.

- Steam connection to a low-pressure steam boiler (3 bar) with automatic steam valve that opens when the rack is fully pulled into the oven. When a PLC is used, the damper and recirculation fan is automatically controlled; the damper can be set to close and stay closed for a certain time. The speed of the fan can be set to a lower value during, and some time after steaming.

PLC - control display information screen


invertor for air speed control, mounted on motor


steam connection

INSPECTION MODULE

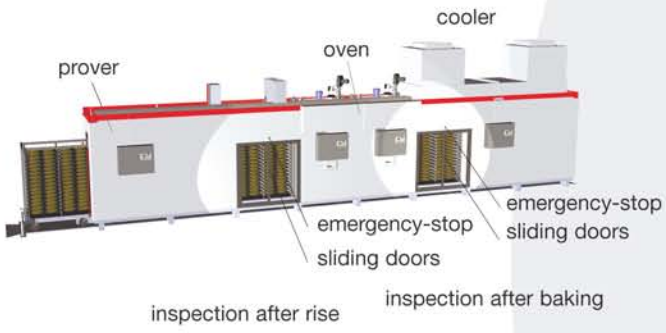
Access to products is provided for quality inspection and so the unit has interior lightning and sliding doors.

Apart from providing an inspection facility, this section of the plant also acts as a pressure equaliser between the oven and cooler. The cooler with its fan mounted on the first and last module, can have a slight pressure difference compared with the oven atmosphere and heat loss from the oven into the cooler is avoided as a result of using an inspection module.

An additional transporter system can be supplied to move the racks out of the bake modules for inspection and to return them, if required, to the oven for a short further baking period.

Construction of the inspection module is similar to the rest of the Dijko Tunnel Rack Baking System, except that the lower part of the side boxes are not enclosed. This permits the pressure equalisation process to occur.

The sliding doors are equipped with safety switches, which ensure the transporter stops immediately when the doors are opened. An audio warning device operates at the same time whilst rack movement is prevented.



3D drawing: inspection module

COOLER MODULES

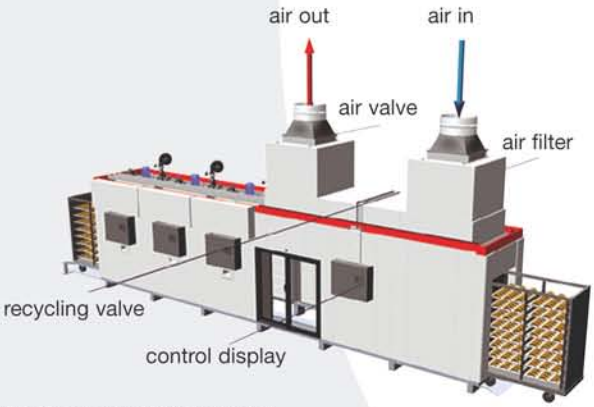
If racks from any oven are taken directly into a bakery, they occupy valuable space, and give off heat, which particularly in summer time makes the working temperature unacceptable. Therefore, cooling times are extended and despatch schedules may be missed. A good cooler is a good investment.

Both floor and side walls of the Dijko Cooler Modules are made from stainless steel with good insulation to prevent condensation forming on the outside of the cooler.

An induction fan is located near the cooler exit, drawing in air from outside the bakery that passes through a filter in the perforated side panel of the last module. The air, slightly warmer, then passes on to the penultimate rack and in turn, until exhausted.

This process can be used for up to three racks, but if four modules are employed, they will be supplied as two sets of modules each with two fans. (A single module would only have one fan). There are two fans in the cooler, both with an optional variable speed facility. They can either be controlled from a panel on the cooler or from a master console.

The second fan in a two or three module cooler is at the oven end of the cooler and extracts product-warmed air through the side panel filters to an outside exhaust. In this way, with the coldest air being applied to the coolest products, maximum cooling is provided with minimal adverse changes to the products during the process.



3D drawing: cooler modules






The volume of air being used regulates cooling capacity; products are being brought down to ambient temperatures quickly. A maximum of 18,000 cubic metres of air per hour is possible with the low noise, low r.p.m. fans which have been carefully selected. The rack when discharged from the module is cool enough to be handled normally.

OPTIONS FOR THE COOLER MODULE

- Automatic temperature control with by-pass air and outside air mix through recirculation and mix valves.

- Complete Stainless Steel execution of exterior and interior.

- Special Filters, with pressure control, which clean the outside air to a pre-determined purity. Pressure difference switches can be placed to check the contamination.

When the standard cooler modules with outside air are not adequate, we can use a deep cooler module with compressor cooling.

The standard deep cooler modules will have an evaporator in the closed air circuit, which will cool down the air to a set temperature. The standard minimum temperature is +3 degrees Celsius.

Outside the building (on the roof or against a wall) we will install the compressor and condenser. Control of air temperature and optional air volume is done either by digital instruments a PLC on the side of the deep cooler or included in a central control console.

Picture: two cooler modules with inspection

picture: deep cooler module

FREEZER MODULES

For products that need to be frozen, Dijko can install freezer modules. The number of modules depends on the product and desired end temperature. For airflow, the modules are wider than the oven modules. Above the racks, the evaporators with fan are installed. The condenser has to be placed outside the building, whereas the compressor(s) can be located in an existing machine room.

Each succeeding module will have a reversed air flow, to freeze all products evenly. Because we should avoid that cold air can escape through the gap between racks and guide rails, a special inflatable silicone rubber is installed between the rack and guide rail. When the rack is moved into position, the seal is inflated and perfectly seals the rack.

Control of air speed and temperature is done by use of a PLC.

Construction of the freezer modules is in stainless steel, with panels insulated with 12cm pur foam.

LOADING/UNLOADING SYSTEM

THE UNLOADING SYSTEM

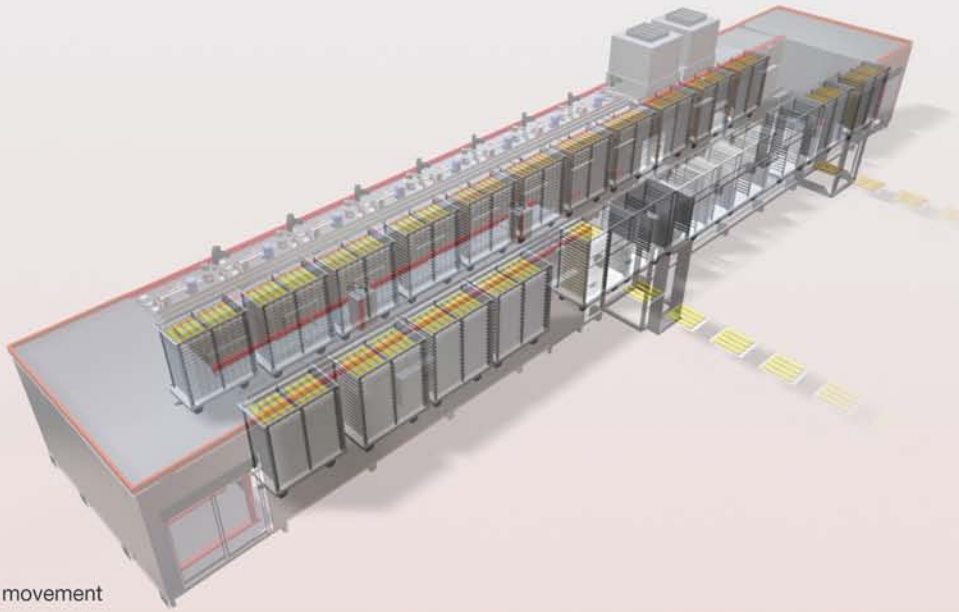
The unloading of the rack is done by an unloading system. The rack stops at a certain point where the unloading system is also located. The trays in the rack are then pushed by an arm, located at the opposite side of the unloading system, on a series of rails. These rails, now with full trays, are transported down by the use of a chain. The trays will then be transported on a conveyor belt towards the next stage of processing.

Picture: unloading system

Picture: loading system

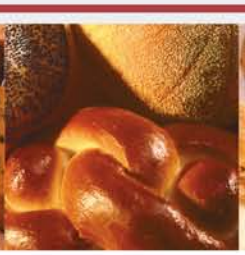
THE LOADING SYSTEM

Loading of the racks is done in a similar way as unloading. The trays arrive by conveyor belt and are automatically loaded in the loading system. After each tray, the rail will move up one stack, until the entire loading system is full. After that, an arm will push all the trays into the rack, and the procedure will start over again.



3D drawing: rack movement



ROBOT HANDLING

Instead of an unloading and loading system, a robot can be used. The advantage of a robot is that you need only one device for unloading and loading the racks, and you can work more flexible. The robot can handle not only trays but also tins. At the end of the robot arm there is a device, which is inter-changeable, for either handling trays or tins. This device can be specially made for the customers needs.

Depending on the number of trays in the rack the robot can unload and load the racks in up to 5 minutes. In the picture below the unloading and loading will take about 10 minutes, it de-pans the bread on a cooler conveyor belt, puts the tins on a conveyor for depositing the tins with the product. The robot picks up the full tins at the end of the conveyor and loads it into the rack.

Picture: robot handling

PLC CONTROL

From the PLC with control unit, which is applied to every module of the prover, oven, cooler and deep cooler or freezer all processes can be controlled (see pictures 1 and 2).

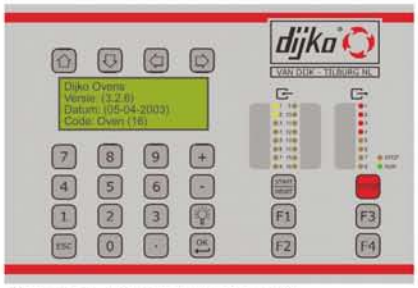
With use of the numeric buttons, the settings for temperature, humidity, steam time, speed of the fan and valves can be altered and retained (see picture 3).

On the display, the active readings of the process can be seen. These are the main screens (see pictures 4 through 9).

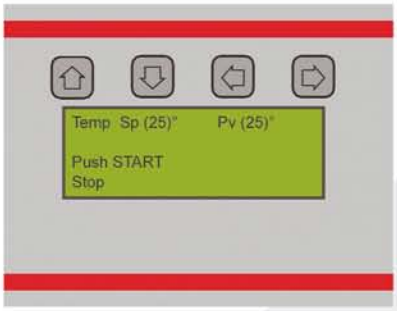
Additionally, all possible errors will be shown in the display to help the user find a solution for the error.

The manufacturer has designed so called service menus, which help when setting the oven.

When using an optional scada system, a two-wire system will supply communication between all PLC's and a central PC.

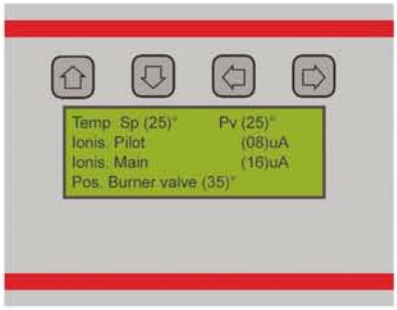


Picture 1 - Control display with information screen

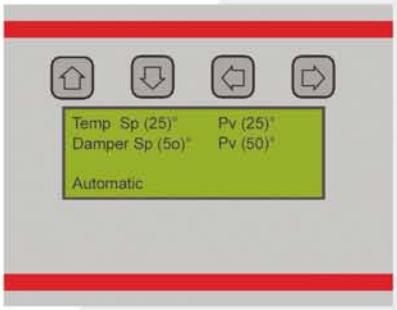


Picture 2 - Start Screen

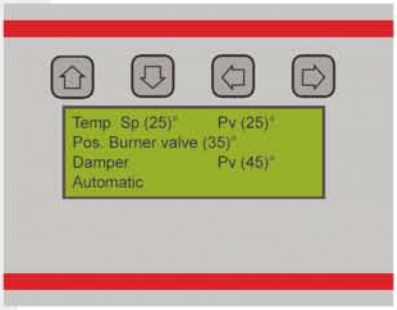
Picture 3 - Numeric Buttons



Picture 4 - Main screen 1

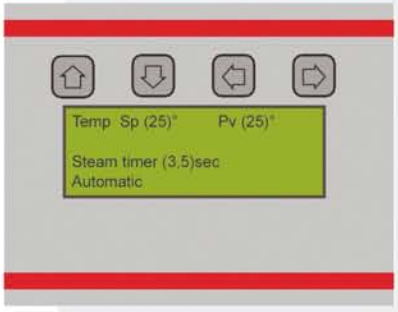


Picture 5 - Main screen 2

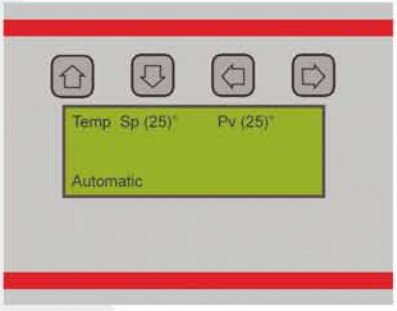


Picture 6 - Main screen 3

Picture 7 - Main screen 4



Picture 8 - Main screen 5



Picture 9 - Main screen 6

CONSTRUCTION

Prover, oven, cooler, deep cooler and freezer modules are all built as entirely independent units, so that a complete system can be installed quickly and simply, by bolting the required modules together - often where it would be impossible to bring in a full assembled oven. All that is required is a level floor area of sufficient strength. (Average loading 1000 kg/m^2).

Both the outer and inner sides of the prover are made of stainless steel, between which is sandwiched insulation material to prevent heat loss.

The inside of the oven module is constructed with aluminium-coated sheet metal whilst the external panelling is of brushed stainless steel. The lower and upper edges as well as supports are painted a warm red colour or when preferred also in stainless steel.

The inside of the cooler module is constructed with aluminium-coated sheet metal and the outside of brushed stainless steel, which is insulated to prevent condensation.

The deep cooler and freezer module are constructed entirely out of stainless steel; the outside is of course brushed stainless steel.

All main connections for gas, oil and electricity are located on the top of the modules.

The wheels of the rack do not require regular maintenance.

OVEN CAPACITY CALCULATION

To determine the number of oven modules required for the fully automatic Dijko Tunnel Rack Oven System, calculate the throughput requirements, the number of racks and oven modules as follows:-

1. *Number of tray levels (E):* E = 1470 : (P + H)

2. *Number of trays per Rack:* Z = E x 2 or Z = E x 3

3. *Throughput per hour:* X = (60 : B) x S x Z

4. *Number of oven modules:* S = (X x B) : (Z x 60)

Explanation:

P	=	Height of product after proof in mm
H	=	Space between the products and the tray above in mm
E	=	Number of levels
Z	=	Number of trays per rack
2	=	Two stacks of trays per rack
3	=	Three stacks of trays per rack
S	=	Number of oven modules
X	=	Number of trays per hour
B	=	Baking time in minutes

Some particular products may require special calculations to be carried out to ensure the system is suitable for those products.

PROVER CAPACITY CALCULATION

It is necessary to calculate the number of oven modules required before working out the number of prover modules for which the relationship between baking and proving time is important.

1. Number of prover modules: N = S x (R : B)

Explanation:

N	=	Number of prover modules
S	=	Number of oven modules
R	=	Proving time in minutes
B	=	Baking time in minutes

CALCULATION EXAMPLES OF OVEN AND PROVER MODULES

1. BREAD ROLLS

Diameter	100 mm
Height	45 mm
Proof time	45 minutes
Baking time	12 minutes
Production rate	12,000 pieces/hr.
Number of rolls per tray	28
Tray size	762 mm x 457 mm (30" x 18")
Rack size	1700 mm x 850 mm

Trays in 3 rows in one rack

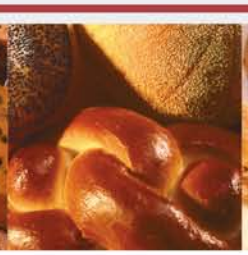
1. *Numbers of levels:*
   E = 1470 : (P + H)
   E = 1470 : (45 + 45) = 16

2. *Number of trays/rack:*
   Z = E x 3 = 16 x 3 = 48

3. *Oven modules required:*
   S = (X x B) : (Z x 60)
   S = (428 x 12) : (48 x 60) = 1,78 = 2 modules

4. *Prover modules required:*
   N = S x (R:B)
   N = 2 x (45:12) = 75 = 8 modules



2. MEAT PIES

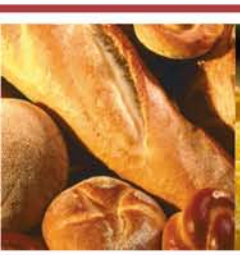
Diameter	100 mm
Height	65 mm
Proof time	- minutes
Baking time	44 minutes
Production rate	10,800 pieces/hr.
Number of rolls per tray	28
Tray size	762 mm x 457 mm (30" x 18")
Rack size	1700 mm x 850 mm

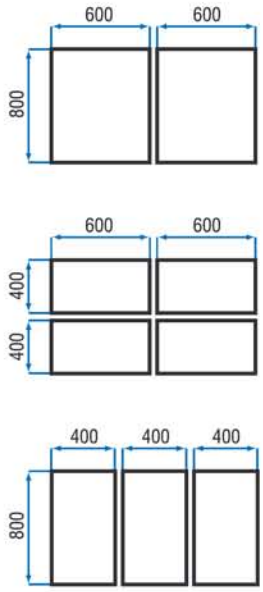
Trays in 3 rows in one rack

1. *Numbers of levels:*
   E = 1470 : (P + H)
   E = 1470 : (65 + 40) = 14

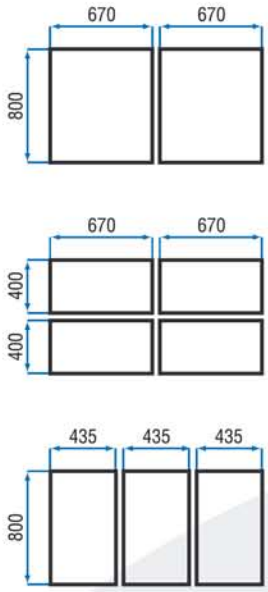
2. *Number of trays/rack:*
   Z = E x 3 = 14 x 3 = 42

3. *Oven modules required:*
   S = (X x B) : (Z x 60)
   S = (385 x 44) : (42 x 60) = 6,7 = 7

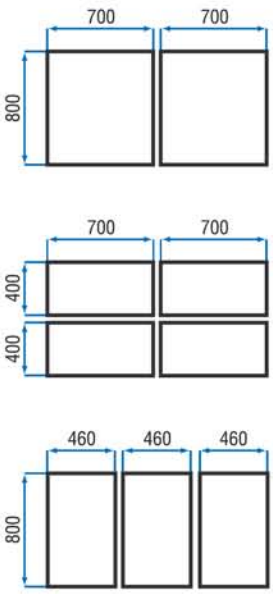


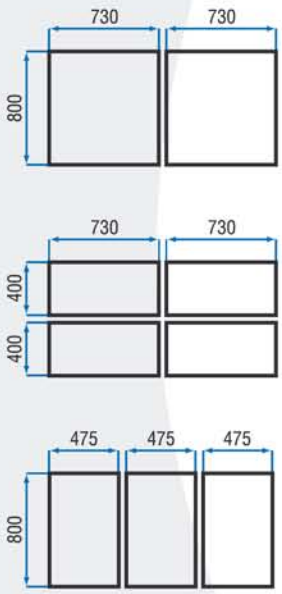
Rack type: 160



Rack type: 160



Rack type: 170



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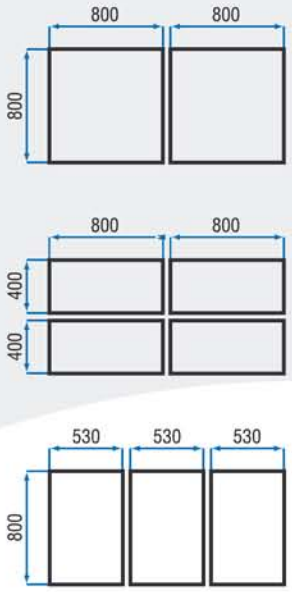

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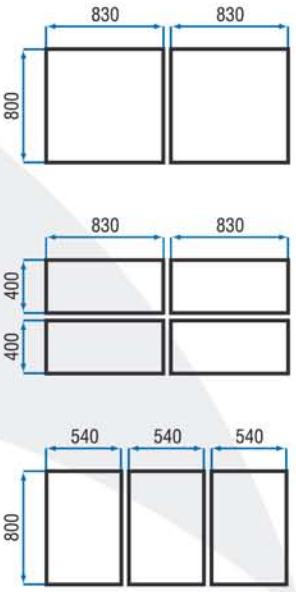

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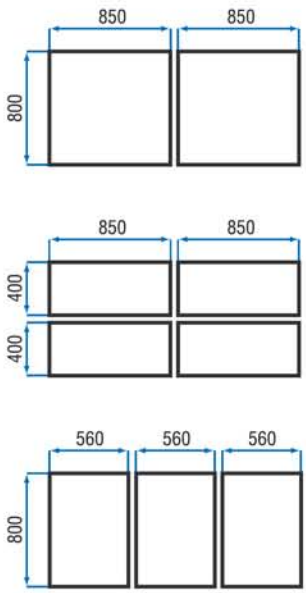

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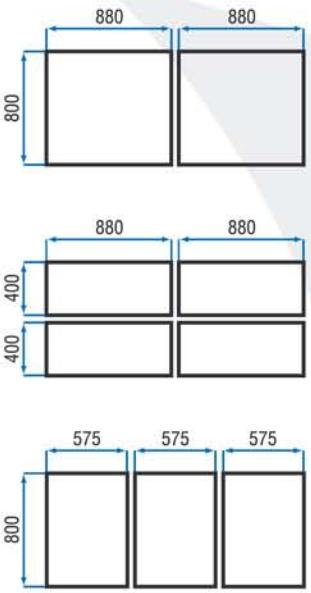

Rack type: 200

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