



Multi-station Linear Indexing machines

This exciting range of machines has been developed for processing small-frame and FHP motors made in high volumes up to 120 units per hour, achieving consistently high impregnation quality.



Multi-station linear indexing machine showing the load / unload station and operator's console

These machines are becoming favourites with manufacturers of motors for electrical appliances, domestic HVAC (heating, ventilation and air conditioning) equipment, pool pumps, compressors, and fork lift trucks, where the number of product variants is small but production rates are high.

Key features of this design concept:

- Modular machines which can be configured to achieve the functionality and throughput required. Modules include: loading / unloading, pre-heating, resin storage and conditioning, resin application, resin curing, cooling products prior to unloading, automatic spray painting, and fume extraction
- Tooling can be configured for handling either stators or rotors in a random mix of sizes
- Flexible, PLC-based control systems incorporating product recognition via barcode scanner, pallet data tags or automatic sensing systems, linked via LAN to factory automation system
- Machines are floor-standing and self-contained, requiring only standard factory services
- Machines generally require only one operator for loading and unloading products
- Machines incorporate fast, clean and efficient short wave infrared (SWIR) heating which only comes on when products are below the required process temperature
- Machines incorporate a resin management system with either trickle or roll dip application

Introduction

The machine comprises two linear indexing systems, one at low level which transports products from the load / unload station through the pre-heating, resin application and curing sections, and one at high level which returns finished products to the load / unload station. Products are taken through the machine on carriages. Tooling can be configured for either stators or rotors.

Detailed descriptions of the main functional sections of the machine

Machine: Products are taken through the machine on carriages which have tooling for either two stators, or two rotors, one on each side of the carriage; these do not have to be identical products and could even be stators on one side of the machine and rotors on the other. Carriages advance through the machine in discrete steps moved by an indexing mechanism and are locked in position between indexing moves. The tooling is driven so that products rotate continuously whilst they are in process. The drive is disengaged at the load / unload station. Products are always referenced to a common point on the tooling.

Pre-heating, resin application and heating the products to resin curing temperature are done at low level. The carriages are then lifted up to high level where the resin cures and the products are then cooled to handling temperature before being returned to low level for unloading.

The machines are double-sided and two products are processed simultaneously on each carriage. Products are normally palletised for transport around the factory and brought on roller conveyor to the machine where they are loaded and unloaded through two apertures protected by light guards. There are ball tables fitted with lift mechanisms at the load / unload station, to assist the operator with product handling.

The machine frame is made from heavy-duty aluminium extrusions and enclosed by panels fitted with toughened glass windows for viewing the processes on the lower level. Interlocked doors are provided where it is necessary to gain regular access for inspection, maintenance or cleaning.

Product heating: Products are normally pre-heated before resin application then heated to cure the resin. Heating is done by short wave infrared (SWIR) radiation which is clean, controllable and efficient, with excellent absorption by the products. Heating rates of 15-20°C/minute in the core of the product are typical. With machines operating on a typical indexing time of 1 minute, it is usual to achieve the temperature rise for each stage of the process over a number of heating stations.

The lamp modules provide radiant heat that is focussed directly on the products from above. Lamp modules have either twelve, or sixteen, 500W quartz halogen lamps, dependent upon the maximum length of product to be heated, and bright aluminium reflectors that absorb very little of the SWIR radiation emitted by the lamps. Each lamp module has a fan that blows air through it for cooling the housing and reflector, and a non-contact infrared pyrometer for measuring product temperature. Product rotation results in uniform heating.



SWIR lamp module

Each lamp module incorporates its own dedicated interface board for monitoring lamp operation and controlling heating. Each lamp in a lamp module is individually controlled, so it is only turned on if there is product directly beneath it, which minimises energy usage. The controller includes a staggered start feature which turns individual lamps on sequentially, to minimise the current surge at the start of each heating cycle, and a soft start feature to prolong filament life. It also monitors each lamp to detect filament failure. Lamp modules are linked via a network to the PLC controlling the machine, allowing extra lamps to be installed easily, if required.

Newtech resin impregnation systems

Resin system: The machine will apply most single-component, heat-curing resins by either trickle or roll dip, dependent upon which method is more suitable for the products and type of resin being applied. These include monomer-based polyester resins, solvent-free 100%-solids epoxy resins, and water-based emulsions. The resin is stored in a large, stainless steel tank inside the machine frame. The tank is fitted with a level sensor which can be used for controlling an optional transfer pump that automatically tops up the tank from a drum of resin standing outside the machine.

For machines applying resin by the trickle method, which is mainly used for stators, resin is drawn from the tank by precision metering pumps and delivered at a controlled rate to the nozzles at the resin application stations where it is trickled onto the winding heads in a steady stream. Whilst the position of one nozzle is fixed at the reference end of the stator, the other nozzle is mounted on a programmable slide which positions it over the opposite winding head. The programmable nozzle can also be used for applying resin on the iron, if required. Product rotation results in uniform resin distribution and excellent resin retention in the windings until it has cured.

For machines applying resin by the dip roll method, which is mainly used for armatures and wound rotors, resin is continuously recirculated by air-driven diaphragm pumps between the storage tank and constant-level dip baths. The dip baths are mounted on programmable slides which raise them up to immerse the face of the rotors to a set depth. If rotors are pre-heated prior to dip rolling, the resin can be passed through a heat exchanger, to remove excess heat. A cleaning station is fitted immediately after dip rolling, to remove excess resin from the outside of the product, using a wiper blade mounted on a pivoted arm, and returns it to the dip bath.

For products that must be double-dipped, or coated with an anti-tracking varnish, a second dip roll station or a spray painting station can be sited downstream of the resin curing section. Further heating may be needed to cure the second coat of resin, or dry the varnish, although this is usually limited due to the residual heat in the product from the first impregnation cycle.

Control system: Machines can be controlled either by a PLC (Programmable Logic Controller) or an industrial PC (Personal Computer) mounted in the electrical services cabinet, which is sited at the opposite end of the machine from the load / unload station. Customers have the choice of Allen-Bradley, Omron or Siemens PLC and electrical equipment.



As well as controlling the mechanical operation of the machine and ensuring processing conditions are achieved and maintained, the controller also handles such tasks as identifying products as they are loaded and selecting the appropriate settings, displaying status messages and warnings on the operator's console, and providing production data via a LAN to the factory automation system.

Changing process requirements: Each machine is configured from standard modules to achieve a certain throughput of products using the resin specified, which determines the build specification, i.e. number of heating stations, overall length of machine, etc. Consequently, major changes to the process, such as changing, say, from a solvent-free 100%-solids resin to a water-based emulsion having very different processing requirements, may necessitate re-configuring large sections of the machine, which can be done relatively easily because of its modular construction.

Other features include:

- Special product handling equipment for integrating the machine into the customer's factory conveyor system
- Automatic fire extinguishers for the electrical cabinets, cable trunking and working sections of the machine
- Automatic spray painting

Newtech resin impregnation systems



Ventilation: The machine has fans for extracting fumes given off by the resin as it cures and for cooling the finished products to handling temperature.

◀ *The two ducted fans on top of the machine (left) draw in air for cooling finished stators on the upper level as they return to the load / unload station and the first bifurcated fan (middle) discharges cooling air to atmosphere. The two bifurcated fans (middle right and right) ventilate the impregnation and curing sections of the machine respectively and discharge the resin fumes to atmosphere.*

AWE Newtech's Linear Indexing impregnation machines offer the following benefits:

- High productivity up to 120 parts per hour with only one operator for loading and unloading
- Consistently high impregnation quality with high slot fill, due to continuous product rotation and rapid curing, achieved in the shortest possible process time
- Compact, self-contained machines taking up minimum floor space, having no requirements for special foundations or special services, which can be installed and re-sited quickly and easily
- Flexible JIT (just-in-time) process capable of supporting one or more winding lines
- Modular construction allowing machines to be configured for the customer's products, resin and production volumes, which can be re-configured if any of these change
- Clean, fast and efficient short wave infrared (SWIR) radiant heating which is as economical to run as a natural gas-fired tunnel oven without the long process times or explosion risk
- Minimum amount of resin stored in the machine, which minimises the resin management problems and the fire risk associated with traditional, large-scale, conveyerised dip plants

Capacity – stators: Nominally IEC 71-frame / NEMA 48 to IEC 200-frame / NEMA 320-series
Max. core length: 280mm / 11" Max. overall length: 354mm / 14"
Bore: 58-92mm / 2.25-3.6" or Bore: 80-140mm / 3.15-5.5"
Max. weight: 50kg / 110lb or Max. weight: 100kg / 220lb

Capacity – rotors: Min. diameter: 60mm / 2.35" Max. diameter: 160mm / 6.3"
(with or without shaft) Max. core length: 280mm / 11" Max. shaft length: 354mm / 14"
Max. weight: 50kg / 110lb

Space required: Width: 4m / 160" including clearance for opening access doors
Height: 2.4m / 96" plus clearance for mounting fans and ventilation ducts
Length: typically 6m / 240" – 15m / 600" (dependent upon the number of stations) including clearance for opening the electrical cabinet doors at one end of the machine and space for the operator to work at the other end

Services required: 3-phase 50 / 60Hz mains electricity + Neutral + Earth / Ground
Clean, dry compressed air at 5.5bar / 80psi
Ventilation ducts connected outside the building to atmosphere
Chilled water for cooling the resin (some roll dip systems only)