

AEM MODELS 2104 AND 2109 CERAMIC TAPE CASTING MACHINES

I. DESCRIPTION

The Models 2104 and 2109 Casters are integrated machines containing all the required features to cast ceramic tape for applications varying from very thin tape for ceramic capacitors, to thicker tapes for ceramic packaging applications.

The Models 2104 and 2109 Casters are precision devices used to deposit a liquid slurry of ceramic powder onto a carrier tape, and then dry it thoroughly. The slurry is deposited with highly controlled thickness. The dried ceramic is subsequently removed from the carrier tape for further processing.

The Models 2104 and 2109 Casters exhibit improved performance over previous designs in the following areas:

- Minimum casting thickness
- Drying characteristics and speed
- Particulate contamination control
- Ease of use

AEM is pleased to quote a ceramic film casting machine incorporating the following features:

A. SAFETY

An explosion proof electrical system to allow the use of either solvent-based or water-based binders. The entire system is designed to comply with the requirements for Class I, Division 2 Hazardous locations. This is done to prevent the possible danger of explosion due to electrical sparks from switches or motors if there is a spill of flammable binder near or on the machine.

Solvent vapor control protects the operator from excessive exposure.

B. DRYING SYSTEM

Heat for drying is provided by recirculating hot water and hot air generated by a water-to-air heat exchanger. The hot water is generated in an electric heater and recirculating pump unit which is located outside the explosion hazard area.

After leaving the casting head, the tape travels over a gradually sloping surface for a distance of 1 meter. This surface is slightly arced so that the tape is pulled flat against it. While traversing this surface, drying is provided in two ways. The first is by volatilizing the solvents through the application of heat from underneath the tape. The second is through the carefully controlled passage of air over the surface of the ceramic. The objective is to remove the solvent as thoroughly as possible. To achieve this, the tape must be prevented from forming a dry skin over its exposed surface. This happens when surface drying proceeds more rapidly than the solvent can diffuse through the cast ware. After leaving the horizontal drying area, the tape passes onto a 42" dia. metal drum. The drum is heated so that the tape is heated while it passes over the drum. The drum carries the tape from the 12 o'clock position to the 9 o'clock position (270 degrees). At this point, it winds over a powered take-up capstan and then onto the storage reel.

By applying heat from below the tape, the rate of diffusion can be controlled to match the surface solvent removal rate. By controlling the flow of drying air at the surface, excessive solvent removal rates can also be avoided. The flow of air must not be so great as to dry the ceramic faster than the solvent can be replaced by diffusion from below. An additional means of assuring this is by putting the fresh air into the system at the dry end of the ceramic tape. As the air travels toward the casting head, it picks up solvent. When the air gets to the wet ceramic where skin formation is the biggest problem, it already is saturated with enough solvent to prevent excessive drying rates.

C. TAPE TRANSPORT

1. **Tracking** Automatic carrier film tracking adjustment is provided to give uniform precise rewinding of cast tape. The tracking system guides the web by sensing the edge and moving the rewind shaft laterally. Each roller in the tracking system is adjustable for easy set up. All rollers have sealed ball bearings for precision and long life

2. **Tension Control** The carrier web is supported on cantilevered spindles for easy changing. The drive capstan is powered by a variable speed motor to provide casting rate control. The drive capstan is located adjacent to the take-up reel so that the web is pulled through the caster. Tension in the carrier web is controlled by use of a magnetic particle (adjustable) drag clutch which maintains a consistent drag independent of speed. The drag clutch is connected to a capstan over which the web must pass before passing through the casting head. The variable speed motor pulls the web from the supply reel around the drag clutch which then provides the required tension in the web. Adjustments are made easily by turning a knob and resetting the clutch adjustment.

3. **Speed Controlled Drive** The drive for the tape transport is provided by an explosion proof AC motor or optional DC servomotor. Speed variation is accomplished via an infinitely variable mechanical gear box. The gear ratio is set by turning a handle which is located on top of the machine. A digital tachometer indicates the actual tape speed by sensing the rotation of the idler roll. The motor and gearbox are located on the base of the machine and are supported by rubber vibration isolators. Drive between the gearbox and the drive spindle is provided by a guarded belt.

4. **Control of Static Charges** Static electricity protection and elimination to minimize contamination of the plastic carrier film. This is provided at the supply roll and immediately before the casting head through the use of alpha emitters.

5. **Contamination Controlled Drying - Temperature and Airflow Controlled Drying Chamber** The entire casting operation is conducted in a filtered air environment within the machine's exterior walls. A class 100 HEPA filter is provided. A glass cover is provided which can be closed while the casting is proceeding. A duct connection is provided for exhaust air which will be vented to an external site.

6. **Casting Station** The casting station is actually a system which consists of three parts. These are the doctor blade box (referred to as the "casting head"), the precision casting surface, and the plastic carrier film. The casting heads are hardened stainless steel box shaped structures EDM machined from solid stainless steel billets to achieve maximum structural stability. They are formed as narrow boxes open to top and bottom. The long edges are ground to form the casting gaps, each at a different thickness. The gaps are formed to 1 micron tolerance. The orientation of the box determines the active gap. The box length determines the cast width. The casting head is designed to be foolproof and easy to clean. One head, with customer specified gaps is provided with each machine. Additional heads with different lengths and /or gaps are available.

For laboratory work an adjustable head with "in operation" adjustment capability is available as an option.

The precision casting surface is a granite block which has been surfaced to be very flat (50 millionths per foot). The film is stretched over this surface so that the film is very flat. In the surface of the block a groove is ground which is about .375" wide and .050" deep. The doctor blade is positioned so that it is directly above the slot as the slurry is cast. The reason for this is that as the tape spans this narrow gap, it remains in the plane of the granite on each side of the gap. However, any surface debris which may be present on the back of the carrier film will not have the opportunity to get between the granite and the film causing thin spots and streaks to be formed in the casting area slurry.

The casting head is positioned by a bracket which fits over the precision casting surface. The bracket provides a locating pocket for the head that holds it in the correct position relative to the slot in the casting surface.

The casting head is fed by a special reservoir which maintains a constant level of slurry in the casting head and is convenient for small batches. A cover is provided for the casting head which prevents evaporation of binder solvents. Automatic fiber optic controlled pressure slurry feed systems are available as an option.

The casting head system is enclosed within the cabinet of the machine for cleanliness. A glass cover is provided so the casting can be observed. A hole in the glass is provided directly above the casting head to provide for feeding of the slurry. A second glass cover is provided to cover the film as it exits the casting area and proceeds toward the drying drum. This cover directs the drying air over the film and provides access to the drum to facilitate threading.

7. **Frame and Cabinet** A heavy aluminum backing plate supports the various functional parts of the machine. For cleanliness and safety, the machine is enclosed in a cabinet. The enclosure contains and directs the filtered air. The machine will be painted according to the customer's preference with an industrial urethane. The top of the cabinet is stainless steel as it is often used as a work surface and will be exposed to binder spills.

8. **Controls** Speed, on/off, blower speed and temperature controls are placed in an easy to access location at the center top of the machine.

9. **Connections** All connections to the machine such as those for heating oil, exhaust air, and electrical service, enter the machine at the top center where they are conveniently grouped. The controls are located at this point as well. Depending on options ordered, the heating controls will be either three valved oil inputs (one for each zone), or simply three lines from the remote automatic controller.

II. SPECIFICATIONS

Specifications are affected significantly by variables under the customers control. This includes the quality and kind of carrier web used, binder type and ceramic characteristics. Speed of casting, temperature settings and machine adjustments are further factors.

Thickness Range: * 5 microns to 400 microns

Accuracy of Doctor Blade: +/-1 micron
Accuracy Casting Surface +/-1 micron

Speed: 2 to 120 in/min
 5 to 304 cm/min.

Width:

Model	2104	2109
Casting wheel	10 inches (245mm)	14 inches (355.6mm)
Carrier tape	9 inches (228.6mm)	13 inches (330.2mm)
Cast film	8 inches (203.2mm)	12 inches (304.8mm)

(Carrier films are typically one inch wider than film deposit)

Power: 220 VAC 50/60 Hz @ 60 Amps, 3 ph.

Ventilation: External vent of 200 CFM capacity required.

Dimensions (caster) : 4.5' High x 2' Width x 6' Long
(1371 mm x 609 mm x 1828 mm)

Dimensions (oil heater) : 6' High x 18" Width x 4' Deep
(1.8 m x .45 m x 1.2 m)

* Depending on the uniformity of slip and ceramic powders.