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# **Alkali Metal Dispensers**



Alkali metal dispensers (AMDs) are small sources of alkali metals which are normally used during the preparation of the photosensitive surfaces of photocathodes.

Generally the alkali metal generating material is a mixture of an alkali metal chromate with a reducing agent. The chromates used are anhydrous alkali metal salts of chromic acid having the general formula  $Me_2CrO_4$  where Me is the symbol used to indicate any one of the alkali metals (Cs, K, Na, Rb and Li).

### SAES ALKALI METAL DISPENSERS

A continuous program of research at SAES Getters S.p.A. into means of controlling the release of alkali metals has led to SAES Alkali Metal Dispensers for the photo-tube industry. The standard dispensers can be used for the release of caesium, potassium and sodium. On request dispensers of rubidium or lithium and with a mixture of any two of the alkali metals are also available.

SAES alkali metal dispensers are particularly suitable for use when one or more of the following problems exist:

- very pure alkali metal films are required
- the rate of evaporation of the alkali metal has to be controlled at will
- the tube must have a vacuum free of harmful gases during formation of photosensitive surfaces
- no loose particles must be present within the tube
- rate of evaporation of the alkali metal must be reproducible
- dispensers must be available in different configurations which can fit in each tube and release different total quantities of alkali metals.

The reducing agent used in SAES alkali metal dispensers is the well known Zr 84% - Al 16% (St 101) getter material.

Besides its reducing action, the St 101 alloy is able to irreversibly sorb almost all the chemically active gases which are produced during the reduction reaction, thus preventing them from contaminating the alkali metal vapour.

The reducing agent/chromate mixture is held within a metal container having a trapezoidal cross-section which is provided with a slit to allow evaporation of the alkali metal vapour.

Within the dispenser's container there is placed a fine, closely controlled diameter, metal wire which partly obstructs the slit eliminating any escape of loose particles.

This type of dispenser can be supplied as a continuous wire or as a precut linear or curved length.

Heating of this type of dispensers is by AC or DC electric current, for this reason the precut lengths of dispenser are normally provided with special terminals to make their use easier and also guarantee a homogeneous heating as well as contributing to the elimination of loose particles.

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## **PRODUCTION OF SAES ALKALI METAL DISPENSERS**

The automated and semi-automated method of forming photocathodes has increased in the past few years the requirement for a consistent and reproducible alkali metal release. Manufacturing AMDs by hand causes inconsistency both in yield and evaporation rate.

The production of SAES alkali metal dispensers is on fully automatic machinery, with built-in quality control safeguards such as dimension monitoring, control of fill, etc. This all takes place in a clean room so that extreme cleanliness and consistent operation of the dispenser is ensured.

## **METHOD OF USING SAES ALKALI METAL DISPENSERS**

In order to release the alkali metal the dispenser must be heated to a suitable temperature under vacuum. This heating first of all starts the reduction reaction between the chromate and the St 101 alloy and subsequently causes the free alkali metal to be evaporated.

Optimum operating conditions depend on the very different requirements and process conditions of different users.

As a general rule, it can be assumed that all the alkali metals evaporate between 550 and 850°C and that an optimum temperature will be found in this range for any given process.

Each working temperature corresponds to a well defined evaporation rate of the alkali metal.

The higher the temperature the higher is the rate of evaporation during the preparation of the photosensitive surfaces.

It is usually preferred to use a rather low rate of alkali metal evaporation and therefore it is advisable to use the alkali metal dispensers at the lower temperature ranges.

## **PROPERTIES**

All SAES alkali metal dispensers have several unique features such as:

1. Consistently reproducible yield, due to:
  - a) a special geometrical design (see enclosed data-sheets).
  - b) very close quality control in production.
2. Low gas emission due to:
  - a) controlled production processing.
  - b) packing in an inert atmosphere in sealed containers.
  - c) the use of an excess of St 101 non-evaporable getter alloy as reducing agent for the alkali compound, which also sorbs, at source, the gas generated in the reaction.
3. Easily controlled evaporation of alkali metals as the reaction is only mildly exothermic.
4. Absence of loose particles that could damage the device where the dispenser is mounted.
5. Suitability for use in modern computer-controlled photocathode formation processes where reproducibility is a must.

## GASES RELEASED FROM DISPENSERS

The gases released from SAES dispensers have been measured after having submitted them to a typical bake-out process simulating the conditions in which the phototubes are normally processed. The quantity was found to be about 1 cc torr/cm where hydrogen was the prevailing constituent.

## ALKALI METAL RELEASE

The release of alkali metals is dependent on time and on temperature. The latter is controlled by the amount of current passed through the dispenser. The practical range of current for most dispensers is from 4.5 to 7.5 A, depending on the rate of deposition required.

Very accurate control of the quantity of alkali metal deposited is therefore achieved simply by controlling the current supply.

Figure 1 shows typical temperature/current curves for SAES dispensers as a function of the temperature of the envelope where the dispenser is located during alkali metal release.

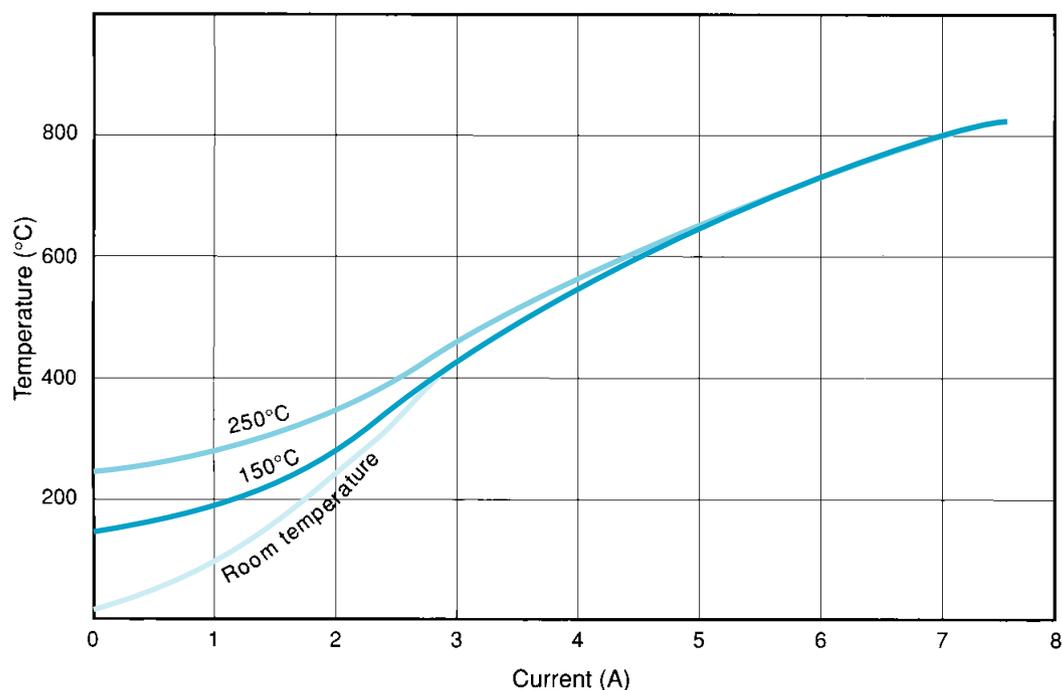


Fig. 1.

Temperature/current curves for alkali dispensers  
as a function of the tube temperature

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**PERFORMANCE CURVES OF SAES STANDARD ALKALI METAL DISPENSERS**

The typical performance curves for the “standard” SAES alkali metal dispensers are shown in Figs. 2-3-4. The experimental curves are obtained by increasing the currents by 0.1 A/min. until the operation current (6.5 or 7.5 A) is reached and then keeping constant the value of the current for different times. The yields of alkali metal are given in mg/cm.

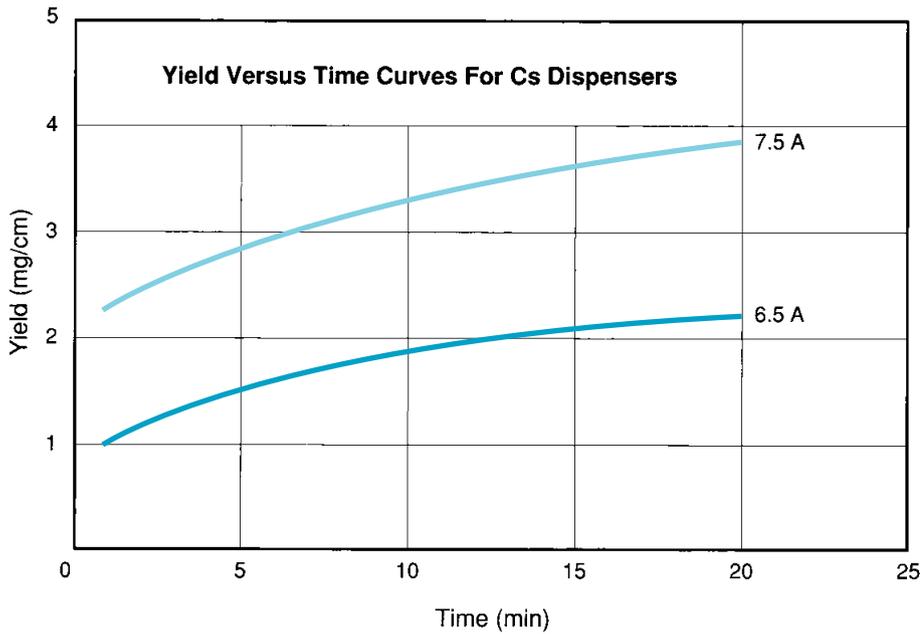
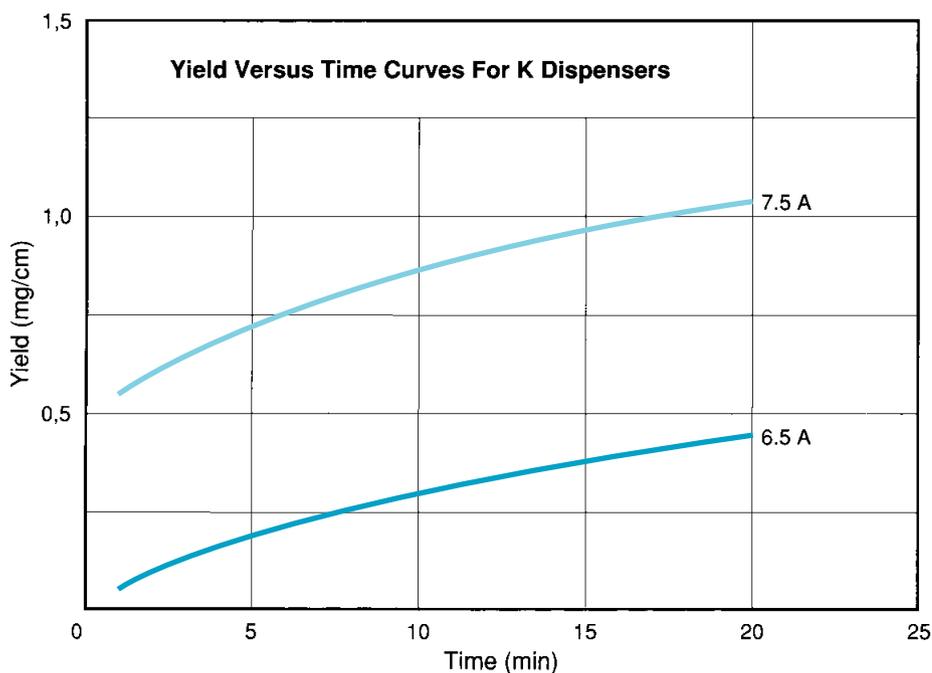
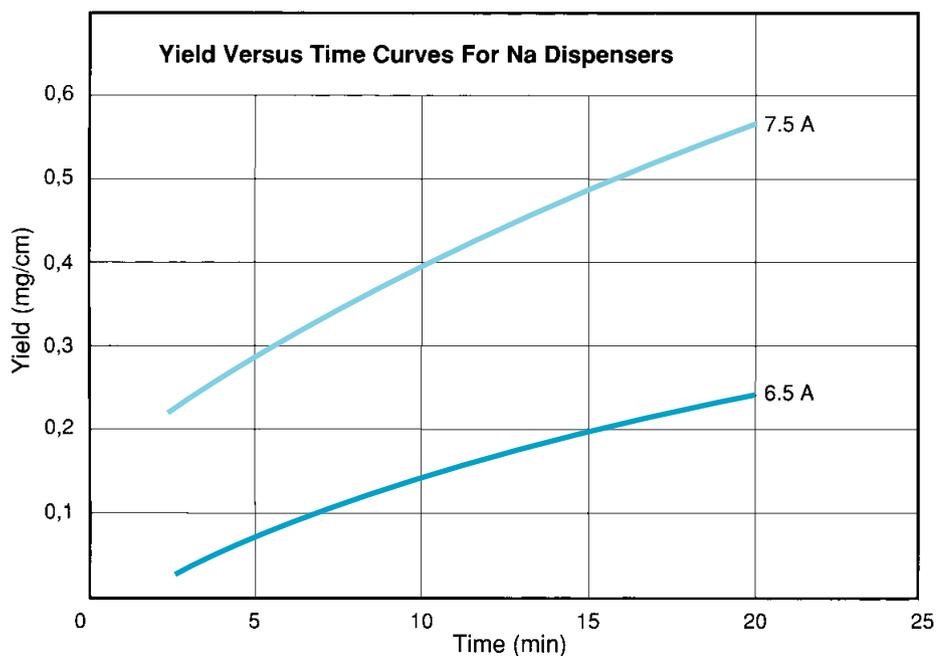


Fig. 2



**Fig. 3**



**Fig. 4**

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## **Packing**

After the production process, the dispensers are packed in sealed tins under dry nitrogen. As a supplementary safety measure a bag of silica gel is included in every tin.

SAES original packing guarantees a one year shelf life.

SAES dispensers can be exposed to the atmosphere for short periods of times without problems.

However, after the original packing has been opened, they must be stored in either dessicators or containers under vacuum.

## **Handling**

The dispensers can be safely handled in the atmosphere before mounting in the device where they are to be employed. However, to avoid contamination, the use of latex or rubber finger cots or stalls is strongly suggested. Cotton or synthetic fibre gloves should be avoided.

## **Applications**

SAES alkali metal dispensers are applicable to the manufacture of any type of alkali photocathode, ranging from the simplest type to complex types for image intensifiers and low light level vidicons.

The main applications of the alkali metal dispensers are:

- First, second and third generation Image Intensifiers
- X-Ray Image Intensifiers
- Photomultipliers
- Image Converters
- Low light level Vidicons
- Surface studies

## CODING

Catalogue code for SAES linear alkali metal dispensers are:

..... / ..... / ..... / ..... / .....

<i>alkali metal</i>	<i>type</i>	<i>nominal yield</i>	<i>active length</i>	<i>type of terminal</i>
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example: Cs/NF/5.4/17/FT 10 + 10

Catalogue code for SAES curved alkali metal dispensers are:

..... / ..... / ..... / ..... / ..... / ..... / .....

<i>alkali metal</i>	<i>type</i>	<i>nominal yield</i>	<i>active length</i>	<i>evaporation direction</i>	<i>bending radius</i>	<i>type of terminal</i>
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example: Cs/NF/5.4/17/E/40/FT 10 + 10

where: E = External evaporation

U = Upward evaporation

I = Internal evaporation

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# Alkali Metal Dispensers with terminals

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**-/NF/-/FT 10 + 10  
series**

SAES dispensers with terminals are intended for the synthesis of all types of photocathode where maximum control and reproducibility of the alkali metal source is needed and where no loose particles can be tolerated. To ensure this, the terminals are designed to provide an even temperature to  $\pm 25^{\circ}\text{C}$  along the active length under all operating conditions.

Identification is by the appropriate chemical symbol engraved on the terminal strip.

All the SAES standard models are now supplied with the "FT type" terminals which have proved to fully satisfy even the most stringent requirements.

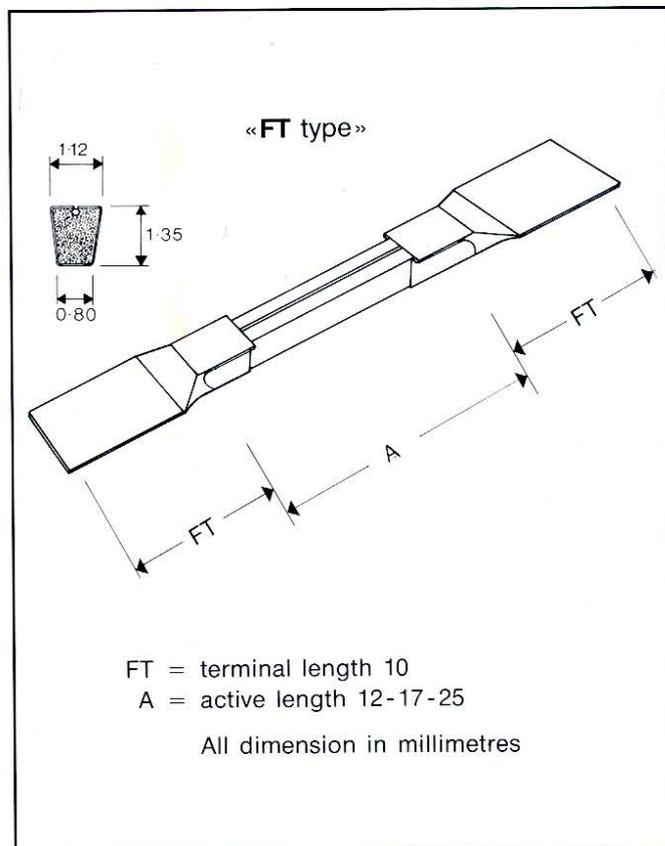
The old "T type" terminals are available only on request.

### Specification

Activation current	<b>4.5-7.5 A</b>
Max degassing temperature	<b>500°C</b>
Standard active lengths	<b>12-17-25-40 mm</b>
Minimum bending radius	<b>40 mm</b>

### Note:

These dispensers can be supplied bent to a specified radius, with the slot internal, external, or even normal to the plane of curvature. The minimum bending radius is 40 mm.



Alkali metal	Content (mg)			Start of evaporation (Amp)*		
	A= 12 mm	A= 17 mm	A= 25 mm	Average	Standard Deviation	
Caesium <b>Cs</b>	5.2	7.3	10.8	4.7	0.2	Standard Production
Potassium <b>K</b>	2.9	4.1	6.0	5.3	0.2	
Sodium <b>Na</b>	1.7	2.4	3.5	6.0	0.2	
Rubidium <b>Rb</b>	4.5	6.4	9.4	5.3	0.2	Only on Request
Lithium <b>Li</b>	0.8	1.1	1.7	7.3	0.2	

\* The evaporation starting point is detected by measuring the sudden increase of the current flowing in a diode placed near the dispenser.

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## Alkali Metal Dispensers

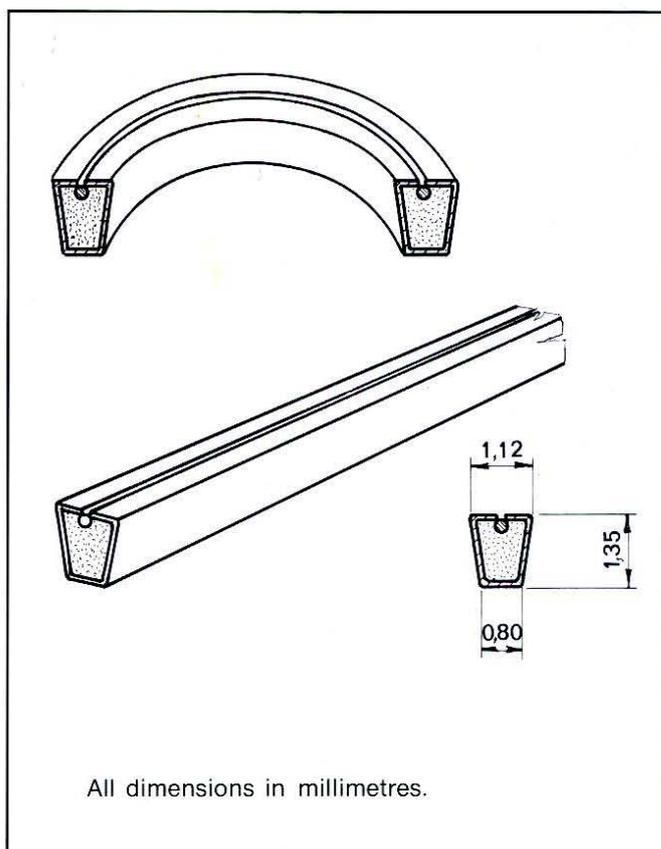
SAES high-yield dispensers in custom cut lengths or continuous wire are suitable for the synthesis of all types of photocathode and are of particular value for the fabrication of appendage generator bulbs, where the remote possibility of loose particles is unimportant, but accurate reproducibility is still necessary. It should be noted that there is a protection wire behind the slot so that no particles can be lost at this point, but here no terminals are fitted so that distortion of the ends when mounting is always a possibility, occasionally leading to some particle loss. Identification is by the appropriate chemical symbol on the packing.

### Specification

Activation current	<b>4.5-7.5 A</b>
Max degassing temperature	<b>500°C</b>
Standard lengths	<b>cut in length as required or as continuous wire</b>
Minimum bending radius	<b>40 mm</b>

### Note:

Cut lengths can be supplied bent to a specified radius with the slot internal, external, or even normal to the plane of curvature.



Alkali metal		Content (mg/cm)	Start of evaporation (Amp)*		
			Average	Standard Deviation	
Caesium	<b>Cs</b>	<b>4.4</b>	<b>4.7</b>	<b>0.2</b>	Standard Production
Potassium	<b>K</b>	<b>2.4</b>	<b>5.3</b>	<b>0.2</b>	
Sodium	<b>Na</b>	<b>1.4</b>	<b>6.0</b>	<b>0.2</b>	
Rubidium	<b>Rb</b>	<b>3.7</b>	<b>5.3</b>	<b>0.2</b>	Only on Request
Lithium	<b>Li</b>	<b>0.7</b>	<b>7.3</b>	<b>0.2</b>	

\* The evaporation starting point is detected by measuring the sudden increase of the current flowing in a diode placed near the dispenser.

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