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1. THE COMPOSITION OF THERMAL PAPER

Thermal paper is a type of paper which is sensitive to heat and which is used for applications employing direct thermal printing technology, i.e., when printing is effected by the use of heat.

The following parts can be distinguished:

- **Base paper.** This paper is the base to which the coating is applied and on which the image will be printed.
- The **under-coating** (or UC layer). This is the first coating which is applied to the base paper so as to guarantee a smoother and more uniform surface on which to apply the thermal coating, making for a more evenly-spread distribution of the latter. A greater degree of smoothness in the coating gives a better resolution and definition (and therefore better quality) of the image during the process of thermal printing. It also develops the ability to absorb the melted products which produce the image.
- The **thermal coating.** This is the second coating, made up of a large number of chemical compounds which, when subjected to heat, react among themselves and develop the image. The main components of this coating are: a colouring; a sensitizing (or co-reacting) agent; and a colour enhancer.

The chemical reaction between the products making up the thermal coating will stop as soon as heat stops being applied through the thermal header, or when there are no more chemical products to react (i.e., when the reaction is complete).

The mode of operation of thermal paper can be seen in Figure 1. As we can see, the thermal coating will be added to the top surface, and it is here that are included the components required for printing.

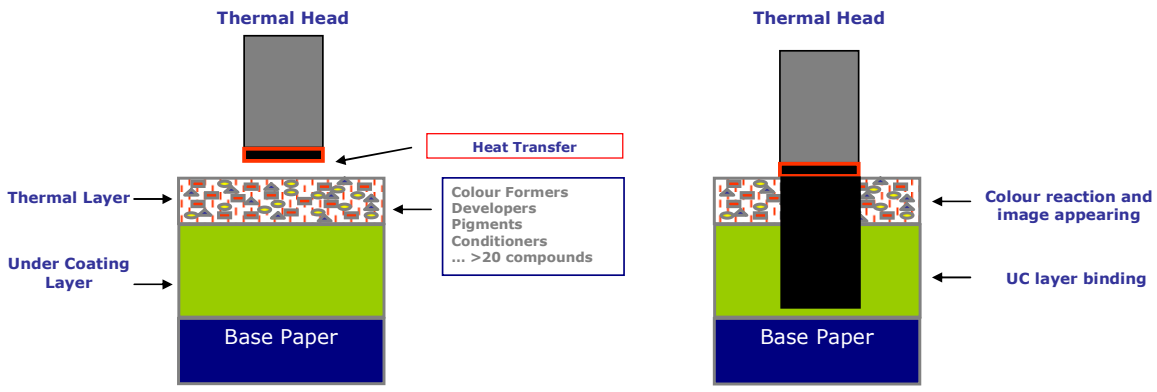


Fig. 1: Mode of operation and composition of thermal paper.

As already indicated above, heat is applied to the paper by means of a **thermal header,** the basic working of which is shown in figure 2. As can be seen, the thermal paper is pulled along by a roller, and on passing through the thermal header the thermal coating will melt, thus reproducing the image that we wish to print (it should be noted that total melting of the coating

does not occur: melting only occurs in the case of the components directly involved in the formation of the image). The melted products are partially absorbed by the under-coating, so that the excess melted material does not stick to the heat-generating header.

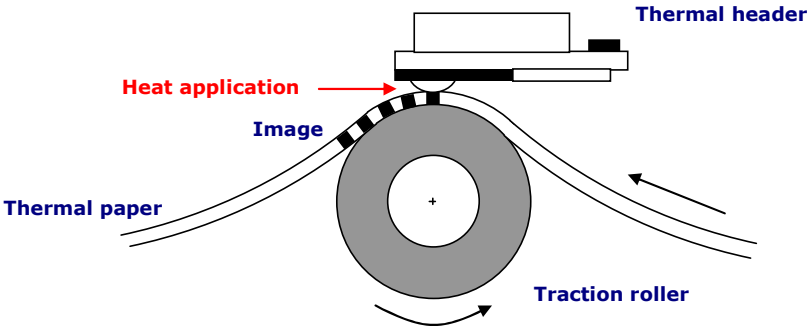


Fig. 2: Heat applications by means of the thermal header.

1.1. Coating Mix

The thermal coating is obtained from a mixture of materials (or coating mix) made up of a series of **chemical products** including a colouring, a sensitizing agent, a colour enhancer, and many other components (we shall see later how the coating is applied to the base paper.) The chemical reaction produced between some of these products is what induces the printing process on the base paper when the heat generated by the thermal header is applied.

In the case of thermal paper, all the products that induce printing are already present in the coating mix itself. This is a fundamental difference with the mixture used for **carbonless paper**, which has a transmitting part and a receiving part which are completely independent.

Another important difference with the coating mix for self-copy paper is that in the case of thermal paper the components must first pass through a **ball mill** to reduce their particle size (since in practice almost all the essential components are grindable, and some of the additives are ground into powder due to the requirements of the formula in order to make up the thermal coating mix). These ball mills are made up of small balls of a very hard material which reduce and standardize the size of the particles of pigment when they collide with them.

Once the components acquire the required particle size, the mix is prepared according to the relevant formula with the colouring, the sensitizing agent, the colour enhancer and the various different types of additive (which are prepared and ground down separately according to requirements before the preparation of the final mix), thus finally producing the required type of thermal coating mix. The process of preparation of the mix is carried out in the **“kitchen”**, or preparation area.

1.2. Base Paper

The base paper is the paper which acts as the base to which the coating is applied, and on

which the required image will be printed. It is important to remember that all the varieties of base paper that we use to produce thermal paper are **self-supplied** (being manufactured in the Group's own factories). If we bear in mind that we also produce our own paper pulp, this is undoubtedly one of the qualitative aspects which can differentiate us from the competition, because, since we produce everything ourselves, it is always easier to control the production system.

2. THE PRODUCTION SYSTEM

The thermal paper produced in our Leitza factory is the end-product of a production process similar to that shown in diagram form in the following illustration. As can be seen in this diagram, the production process in Leitza starts with the application of the thermal coating, since the base paper comes form other company factories.

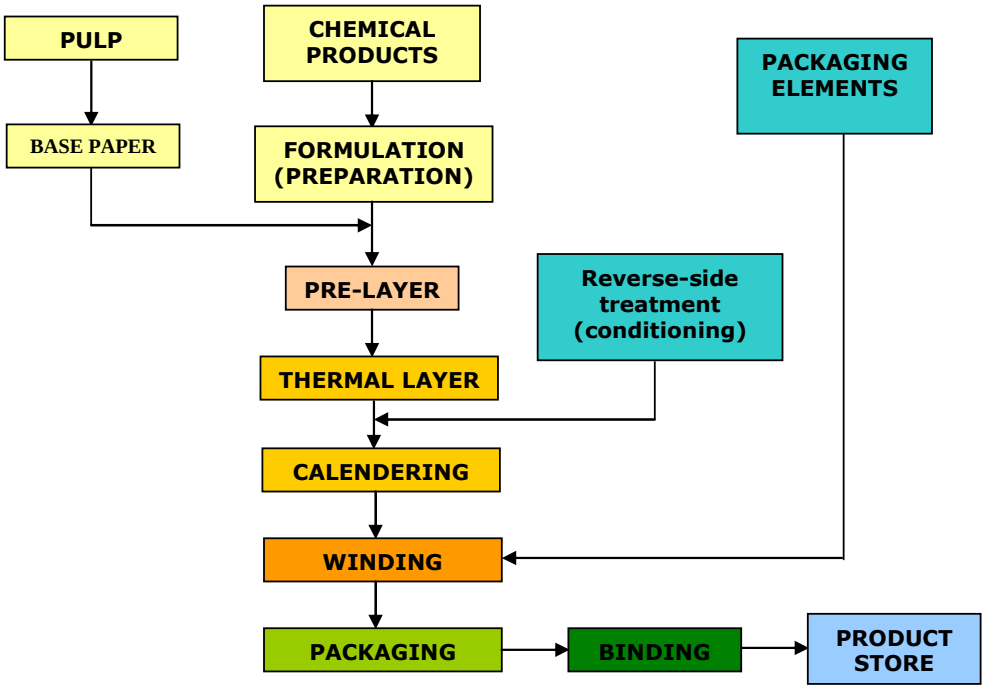


Fig. 3: Production process of thermal paper in Leitza factory.

Once the base paper has arrived in Leitza, the production process can be divided into the following operations:

- The first is the application of a first coat (**under-coating**) in order to improve the paper's printing properties.

- To the under-coating is subsequently applied the **thermal coating**, the mix for which (made up of colouring, colour enhancing, etc.) will have been previously prepared according to formula in the "kitchen" (or preparation zone). After the application of the coating and inside the same machine, a partial calendering process takes place so as to improve the

smoothness of the paper.

- Once the coating is dry, the thermal paper passes through the finishing section, where it will be subjected to various different operations: **winding, packaging and binding**.

- The thermal paper is finally sent to the **finished products warehouse,** where it will be kept while waiting to be sent to the final customer.

The finishing process for thermal paper is always completed in reels, and our direct customers who handle this type of paper transform it into smaller reels for use in different types of printing machine. In many cases the machines are small, such as, for example, those used to print toll tickets on motorways, car-park tickets, bank statements, etc.

We shall comment on the use of this product at the end of the unit, when we speak about the different qualities that we produce.

3. THE APPLICATION OF THE COATING

We have already mentioned that thermal paper normally has two coatings on the same side of the paper, and that these are called:

- The **under-coating**, which is applied to the base paper to improve its suitability for printing (giving a smoother and more even surface, a better quality of image, a more even distribution of the thermal coating, etc.).

- The **thermal coating,** which is the upper layer that contains the chemical products that will react among themselves on coming into contact with the thermal header, thus carrying out the printing process.

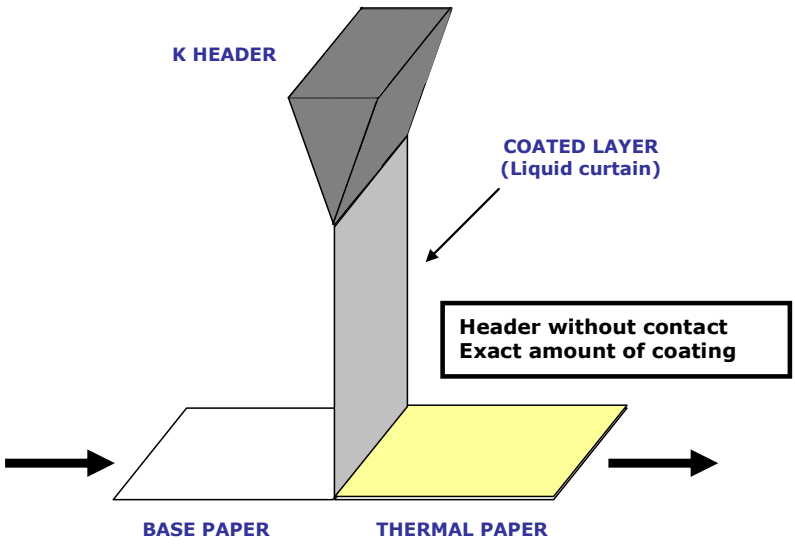


Fig. 4: Application of the coating layer with the K header (Fuji trademark).

The thermal coating benefits from a high degree of evenness across the whole width of the reel, given the high technology of the system used for its application. This system (also known as the "curtain coating" system) employs a K header that applies the coating mix in such a way that it falls on the paper in the form of a curtain (fig. 4). In this case, the distribution of the thermal coating is carried out without using any elements of pressure control, since the quantity of coating applied is regulated exclusively by adjusting the coating flow and through the speed of the paper.

The drying of the thermal coating is carried out by hot air and dryer. The drying process takes place at a low temperature in order to avoid the paper being developed.

Finally, in order to check the quality of the thermal coating, a sensitivity test is carried out, which indicates the optical density of the coating in function of the energy/temperature applied, and which has two distinct aspects, as described below:

- **Static Sensitivity:** Index of the temperature at which the paper starts to react.

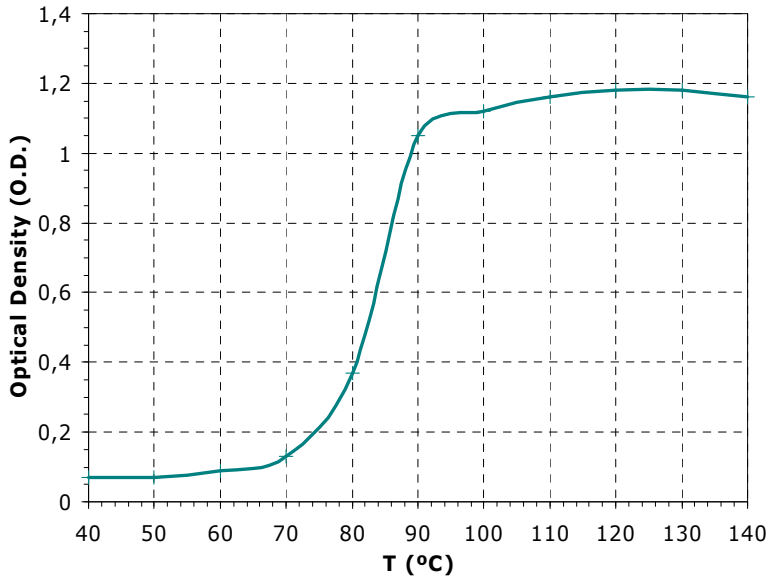


Fig. 5: Static sensitivity graph of Termax P-55 S

- **Dynamic Sensitivity:** Shows how fast thermal paper can be printed. It relates the quantity of energy to be applied to the density of the coating. The smaller the amount of energy required, the faster the printing.

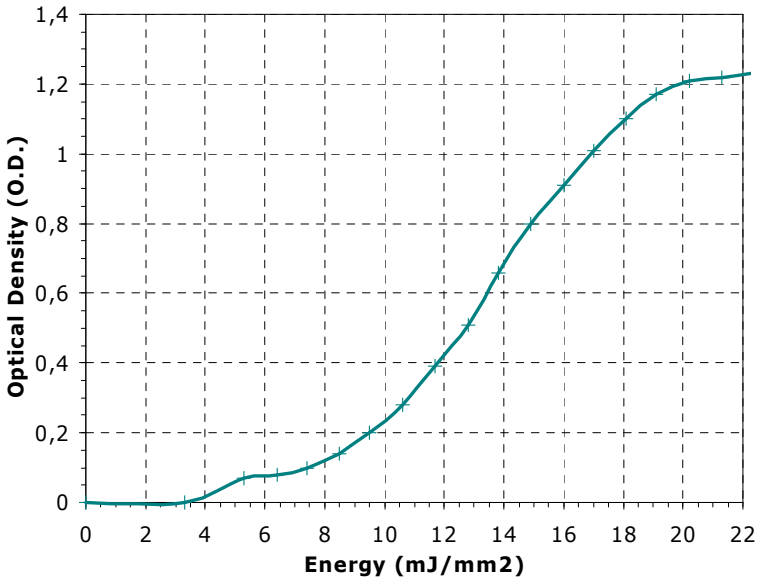


Fig. 6: Dynamic sensitivity graph of Termax P-55 S

3.1. The protective coating

Depending on the final use for which the product is intended, it is sometimes necessary to apply an additional coating to make the paper especially resistant. The protective treatments concerned are entirely independent, and are usually of two types:

- **Protection of the thermal coating:** this protects from external factors such as mechanical abrasion, chemical products, climatic factors, plasticizers, etc.
- **Protection of the back side:** this protects against spillage of chemical products. It is especially recommended when an adhesive is applied. For example, there are some uses of thermal paper, as is the case with self-adhesive products, for which, depending on the type of adhesive used, it can be necessary to use a treatment having the effect of a protective barrier for the back side.

In this way, different types of paper can be protected, unprotected, or even semi-protected in the case of treatments which modify the thermal layer itself, making an additional layer unnecessary. This type of treatment is becoming more and more common, since if it is true that in the past thermal paper was essentially used for fax transmissions, these days other final uses which require this type of treatment are becoming more and more frequent.

4. THE ADVANTATGES OF THERMAL PAPER

There is no doubt that thermal paper offers a number of significant advantages, which we resume as follows:

- It is **economical** because it does not need toner, tapes or other consumable printing material. Moreover, the energy consumption of a thermal printer is very low.
- Direct thermal printing is a system which offers **great reliability.** The quality and resolution of the printed image is constant, independent of the amount of data or sheets used, since it does not depend on the level of ink, toner or tape. It is furthermore a silent printing system. Thermal printers have very few mobile components.
- It offers **great flexibility of size,** since it accepts a large number of formats for printing, from a few centimetres to large formats.
- From an **ecological** viewpoint it is also interesting, since there are no consumable materials.
- There is no limitation to the **number of sheets.** In the case of thermal paper, copies come out individually. This aspect can be seen when we pay with a credit card: if the paper used is self-copying, the two sheets that we sign will come out together and we will have to separate them, keeping the copy for ourselves; however, when thermal paper is used, the sheet that we have to sign and the copy come out.

5. TYPES OF PRODUCT

Thermal paper is mainly used for point of sale receipts (POS), tickets and labels.

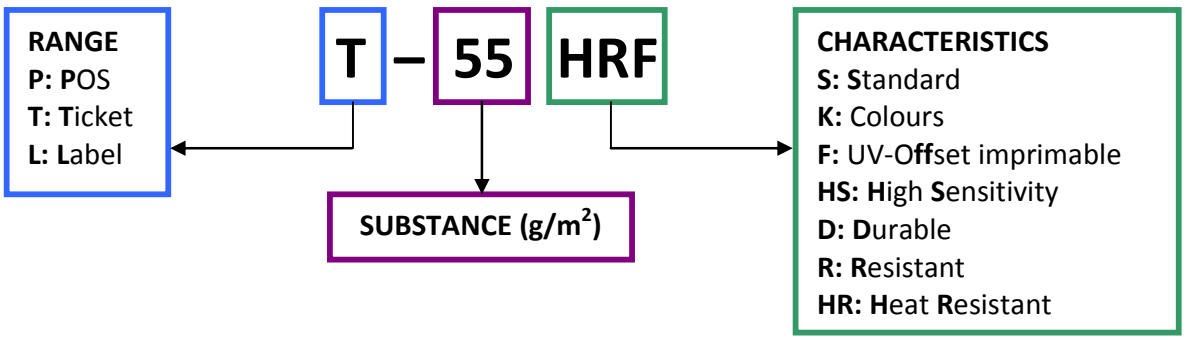
In our case, the commercial name of the product we produce is **Termax,** and details of the product range can be found in the following chart, with indications of its principal characteristics, final uses, and the different substances in which it is produced. All the product profiles correspond to non top coated papers, except in the case of Termax P-59 RF, T-55 HRF, T-75 HRF and T-105 RF qualities, which are semi-top coated.

RANGE	Commercial Quality	Substance (g/m^2)	Dynamic Sensitivity	Image Durability (years)	UV-offset Imprimability	DESCRIPTION
POS	Termax P-55 S	55	Estándar	5		Standard thermal paper for point of sales receipts (POS), bank statements and fax.

RANGE	Commercial Quality	Substance (g/m^2)	Dynamic Sensitivity	Image Durability (years)	UV-offset Imprimability	DESCRIPTION
POS	Termax P-58 S	58	Standard	5		Standard thermal paper for point of sales receipts (POS), bank statements and fax.
POS	Termax P-55 SD7	55	Standard	7		High sensitivity standard thermal paper for point of sale receipts (POS), bank statements and medical charts.
POS	Termax P-55 SK	55	High	5		Standard coloured thermal paper for point of sale receipts (POS) and bank statements. Available in pink, blue, green and yellow.
POS	Termax P-57 F	57	Standard	5	✓	High sensitivity thermal paper for point of sale receipts (POS), bank statements and medical charts.
POS	Termax P-55 HS	55	High	5		Very high sensitivity thermal paper for point of sale receipts (POS) and medical charts.
POS	Termax P-59 RF	59	Very High	7	✓	Thermal paper resistant to heat, light, moisture and plasticizers. Specially designed for point of sale receipts (POS) and coupons.
TICKET	Termax T-74 F	74	Standard	5	✓	High sensitivity thermal paper for lottery and gaming tickets, bank statements, invoices, transport tickets, receipts and coupons.
TICKET	Termax T-80 F	80	High	5	✓	High sensitivity thermal paper for lottery and gaming tickets, bank statements, invoices, transport tickets, receipts and coupons.
TICKET	Termax T-105 F	105	High	5	✓	High sensitivity thermal paper for transport tickets, coupons, entrance tickets and tags.
TICKET	Termax T-80 HS	80	High	5		Very high sensitivity thermal paper for lottery and gaming tickets, bank statements, invoices, transport tickets, medical charts and receipts.

RANGE	Commercial Quality	Substance (g/m^2)	Dynamic Sensitivity	Image Durability (years)	UV-offset Imprimability	DESCRIPTION
TICKET	Termax T-55 HRF	55	Very High	5	✓	Low sensitivity thermal paper resistant to heat, specially designed for parking tickets.
TICKET	Termax T-75 HRF	75	Low	5	✓	Low sensitivity thermal paper resistant to heat, specially designed for parking tickets.
TICKET	Termax T-105 RF	105	Low	7	✓	Thermal paper resistant to heat, light, moisture and plasticizers. Specially designed for entrance tickets, tags, transport tickets, lottery and gaming tickets.
LABEL	Termax L-74 F	74	Standard	5	✓	High sensitivity thermal paper for self-adhesive labels.
LABEL	Termax L-105 F	105	High	5	✓	High sensitivity thermal paper for self-adhesive labels.

The commercial qualities are named as described in the following legend:



Thus, we know that Termax T-55 HRF quality, for instance, is a 55 g/m^2 thermal paper for tickets, UV-Offset printable and that offers a good heat resistance.