



Quality of Thermal Papers

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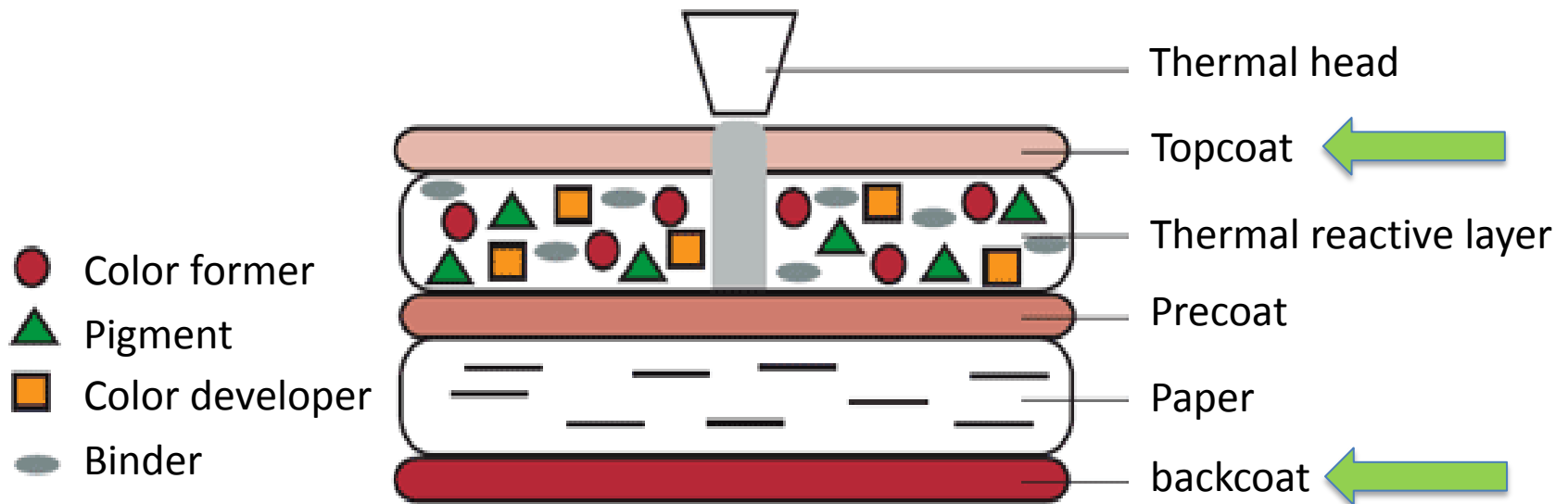
Institute for Technological Research from State of São Paulo - IPT



Introduction

Thermal Paper:

special paper with a coat containing a heat sensitive dye.





Introduction



High speed



Low cost



Easy to use



Comet



Introduction

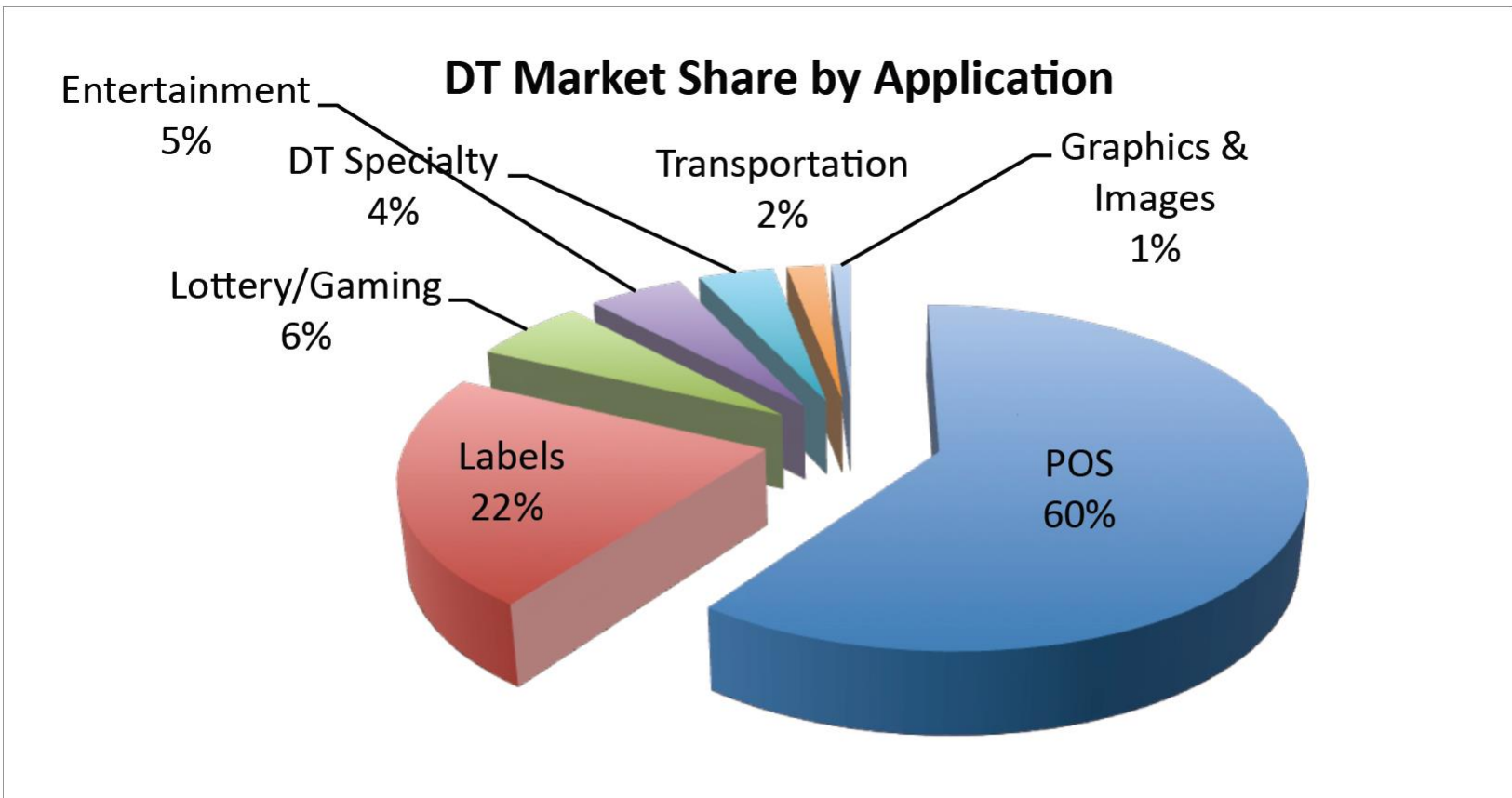


Figure ES-14 Direct thermal application share



Introduction

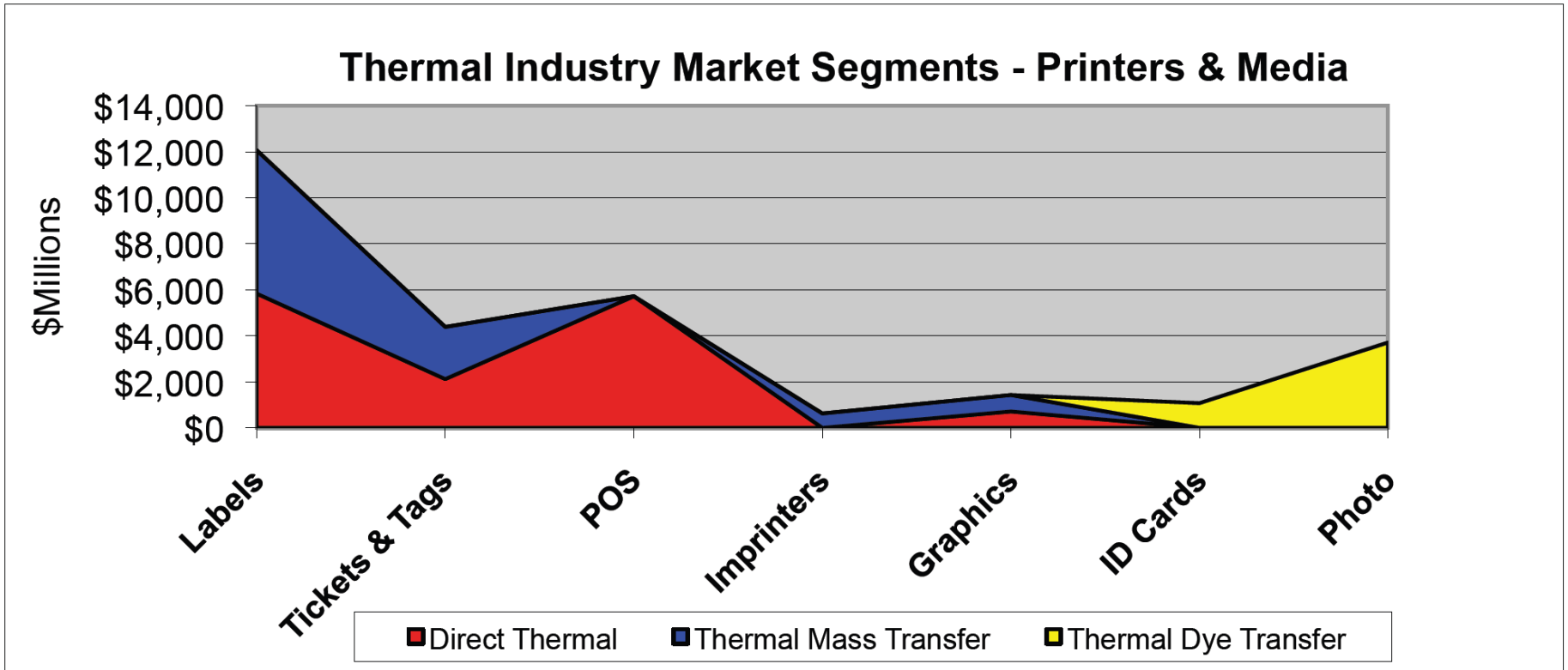


Figure ES-2 Thermal industry market spectrum – end user level



Introduction



Brazilian Legislation: Ato COTEPE ICMS n. 4
(March 11th, 2010)



Italian Legislation: All´Allegato E
(March 23th, 1983)



Other Countries: end user should demand
quality control from
manufacturers



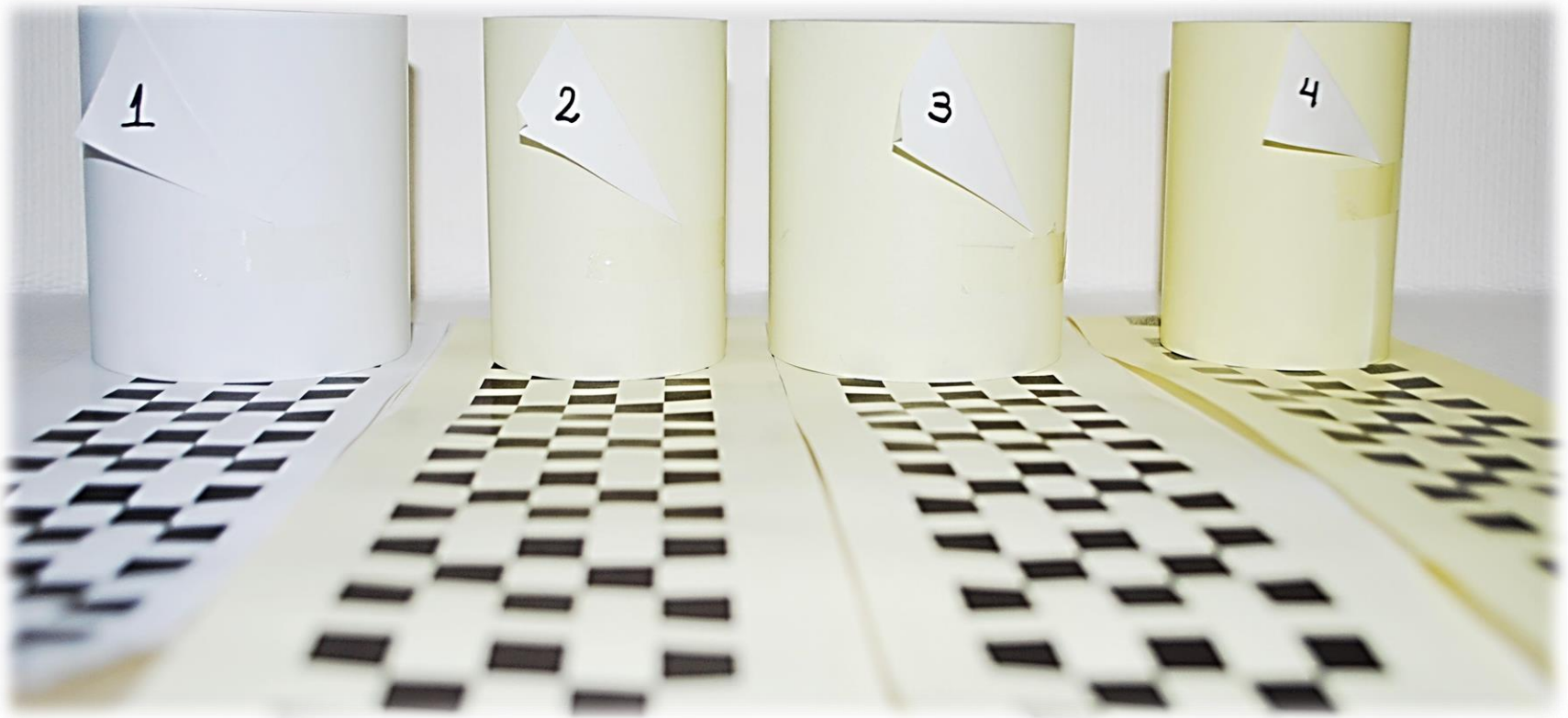
Goals

Quality evaluation of thermal papers for point of sale system (POS) and discussion of quality control parameters for thermal paper.



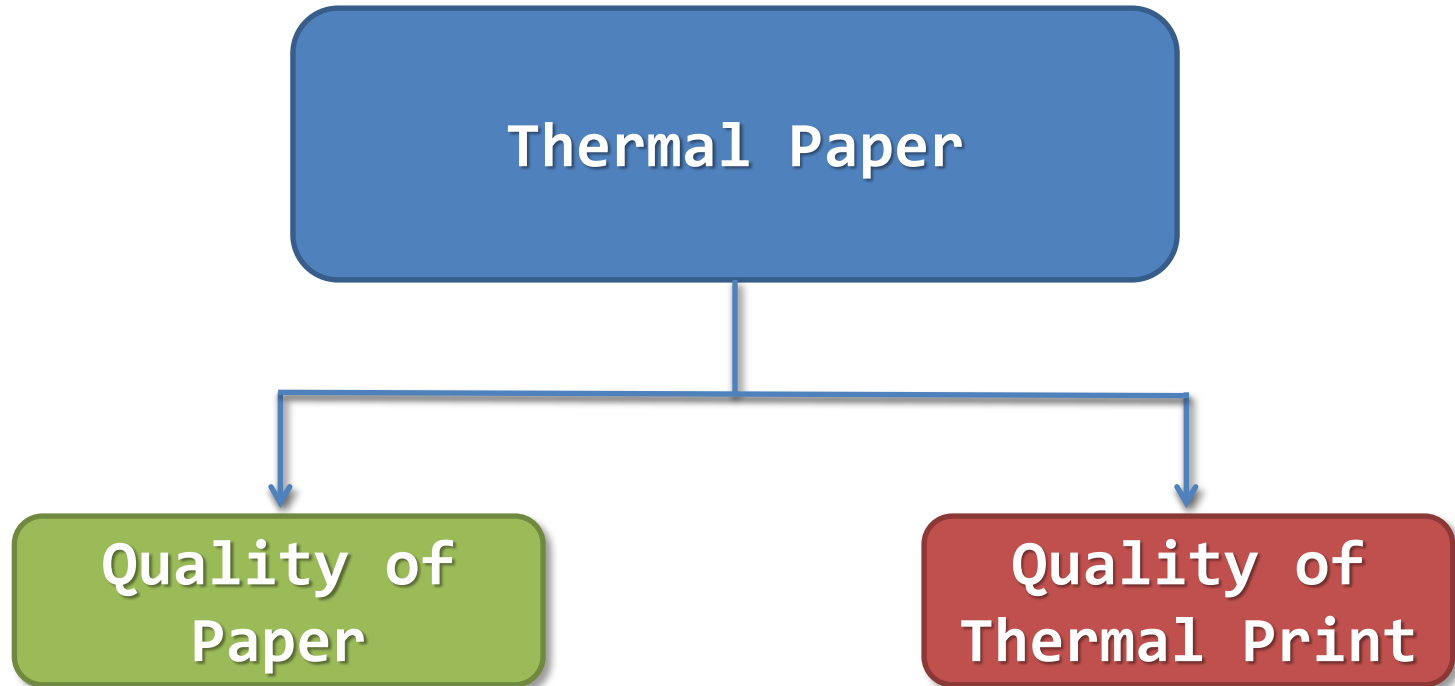
Samples

4 thermal paper samples for POS





Procedures



Quality of Paper

Quality of Thermal Print



Quality of Paper

Quality of Paper

Grammage

Thickness

**Smoothness
(Bekk Method)**

Influence paper
resistance to
physical damage
caused by handling

Related to printer
damages caused by
friction between
paper and print head



Quality of Paper

Table 1 - Results

Sample	Grammage (g/m ²)	Thickness (μ m)	Bekk Smoothness (s)
1	56.0 \pm 0.3	63 \pm 4	717,1 \pm 20,0
2	56.6 \pm 0.3	68 \pm 4	827,2 \pm 23,5
3	53.9 \pm 0.5	63 \pm 4	757,1 \pm 25,7
4	54.3 \pm 3.3	62 \pm 4	591,9 \pm 20,9

Table 2 - Requirements

Country	Grammage (g/m ²)	Thickness (μ m)	Bekk Smoothness (s)
Brazil ¹	50 - 65	55 - 70	> 300
Italy ²	48 - 70	50 - 75	\geq 200

1 - Ato COTEPE/ICMS nº4, de 11 de março de 2010. *Diário Oficial da União*, Brasília, DF, seção 1, p. 8, 17 mar. 2010

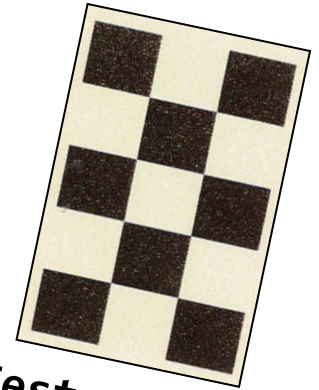
2 - Provvedimento del 30/01/2012. *Sostituzione allegato E al D.M.* 23 marzo 1983, introdotto dal D.M. 30 marzo 1992



Quality of Thermal Print

Quality of
Thermal Print

Thermal Print
(energy density = 13,166 mJ/mm²)



Test pieces

- *Evaluation by Optical Density (O.D.)* - ASTM F 2036-05:2007 using a spectrodensitometer X-Rite Model SpectroEye

$$DO = \frac{1}{R} = \left(\frac{I_0}{I} \right)$$

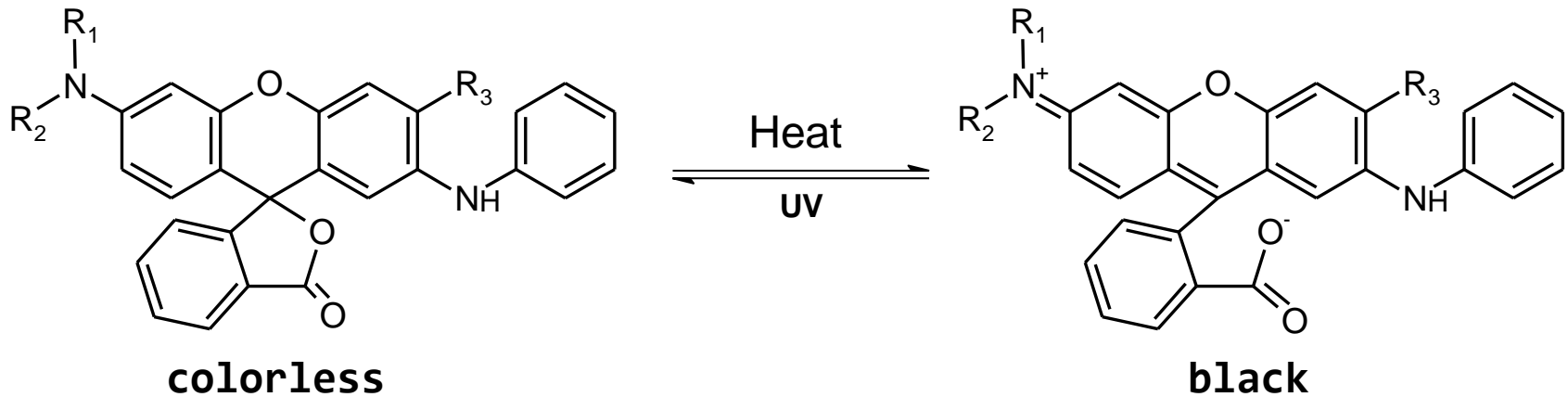
DO = optical density
R = reflectance
 I_0 = initial intensity of incident light
I = intensity of light reflected by surface



Quality of Thermal Print

Why the energy employed is important?

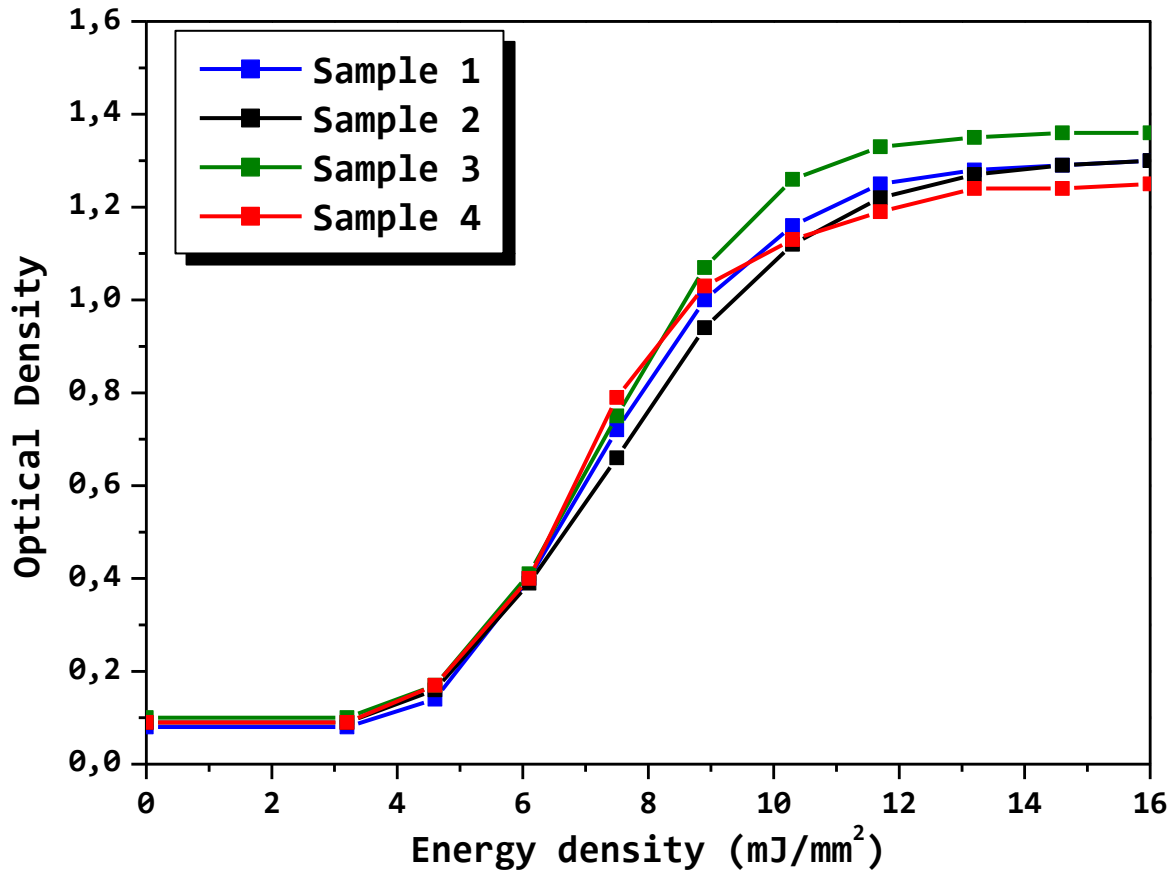
Thermal Dye - leuco





Quality of Thermal Print

Dynamic Sensitivity: how much energy needs to be applied to the paper for the image to be developed.



mJ/mm²

3,2

4,6

6,1

7,5

8,9

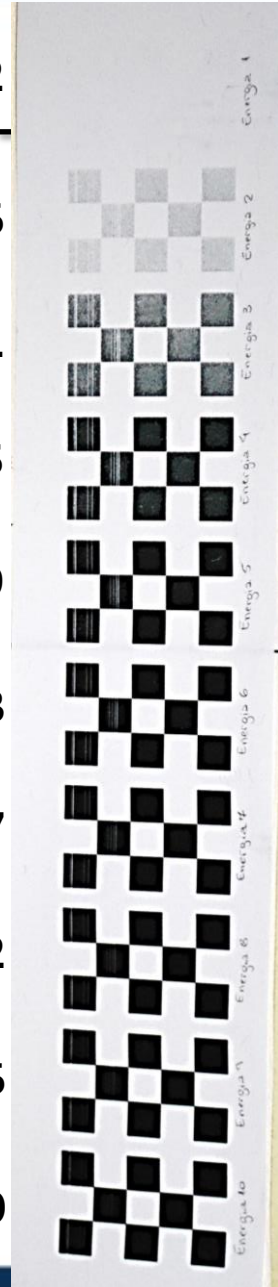
10,3

11,7

13,2

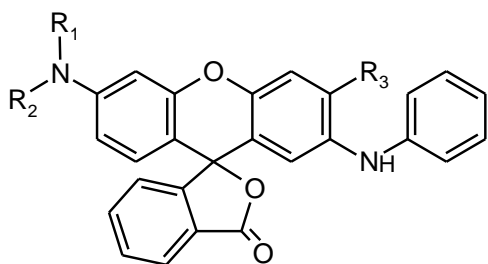
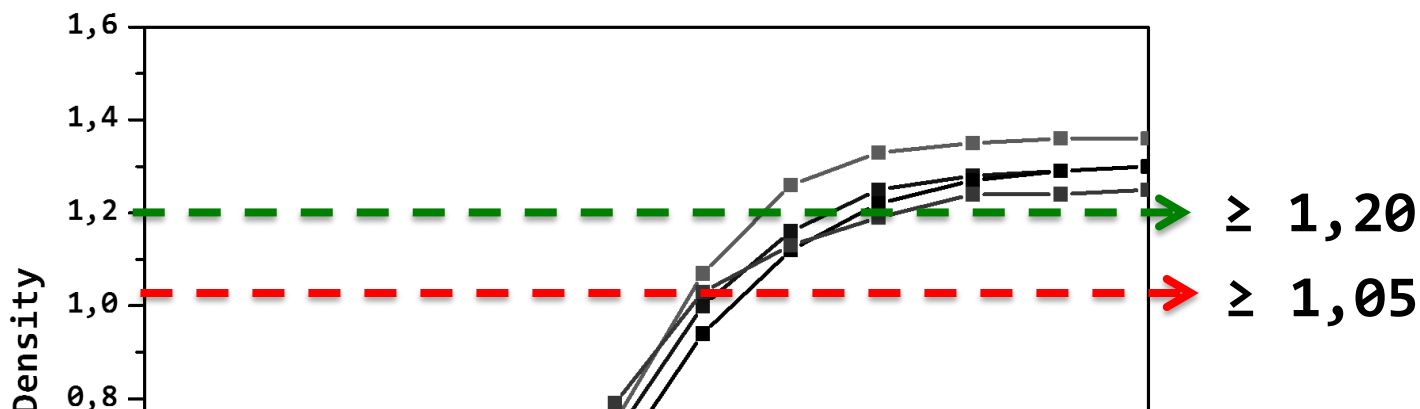
14,6

16,0

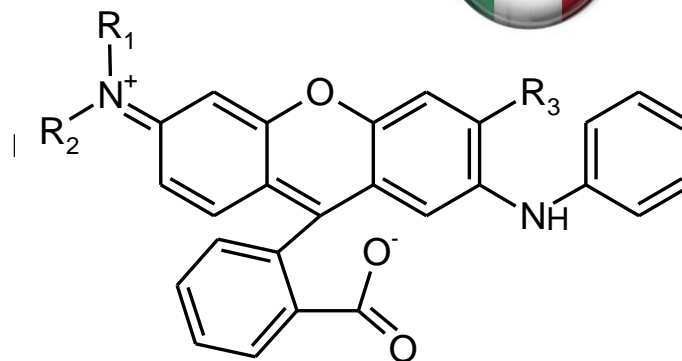
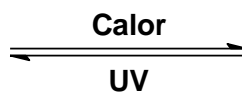


Quality of Thermal Print

Legislation Requirements



colorless



black



Quality of Thermal Print

Table 3 - Optical density results

Sample	<i>After print</i>
1	1.24 (0.04)
2	1.36 (0.01)
3	1.34 (0.01)
4	1.32 (0.01)

Note: The results are average values of 25 determinations and each number between brackets is the standard deviation.

Table 4 - Requirements for optical density

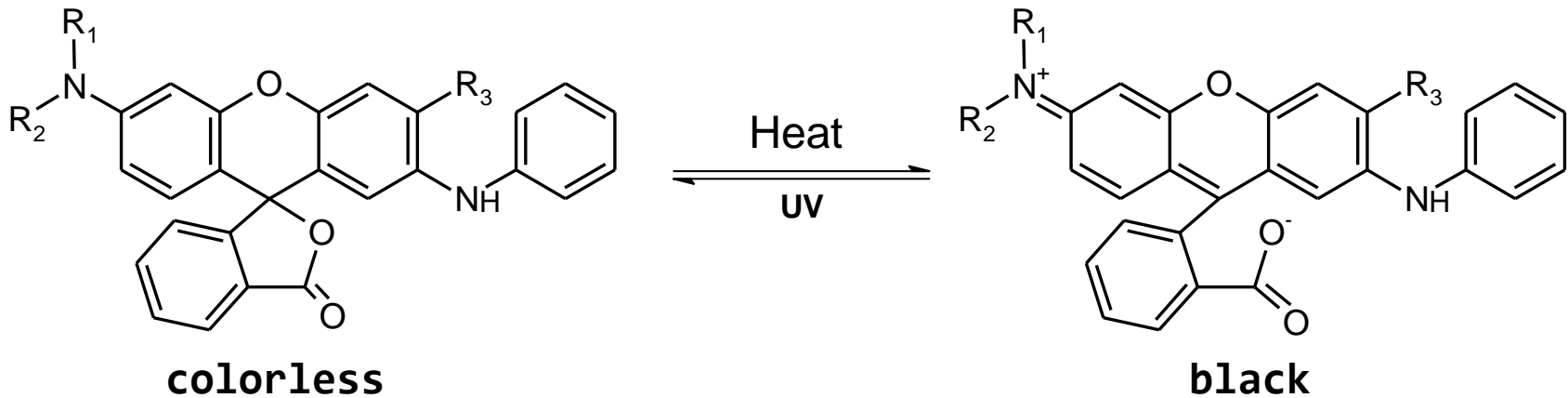
Country	<i>After print</i>
Brazil ¹	≥ 1.20
Italy ²	≥ 1.05

1 - Ato COTEPE/ICMS nº4, de 11 de março de 2010. *Diário Oficial da União*, Brasília, DF, seção 1, p. 8, 17 mar. 2010

2 - Provvedimento del 30/01/2012. *Sostituzione allegato E al D.M.* 23 marzo 1983, introdotto dal D.M. 30 marzo 1992

Quality of Thermal Print

What can affect the image?



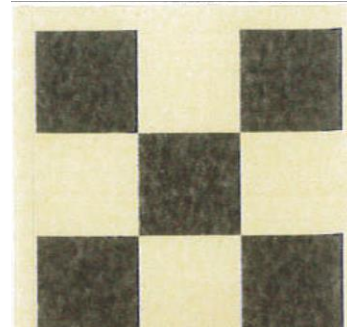
- Extreme conditions of heat and humidity;
 - UV light;
 - Chemical substances: water, oil, plasticizers, organic solvents and others
-



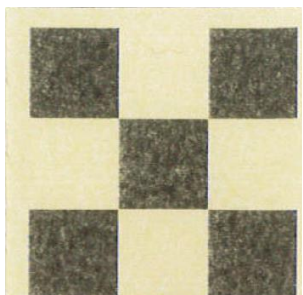
Quality of Thermal Print

What can affect the image?

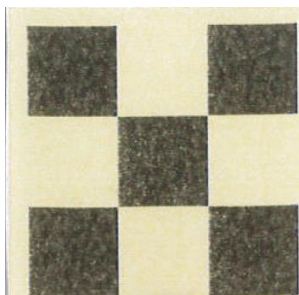
- Extreme conditions of heat and humidity;
- UV light;
- Chemical substances: water, oil, plasticizers, organic solvents and others



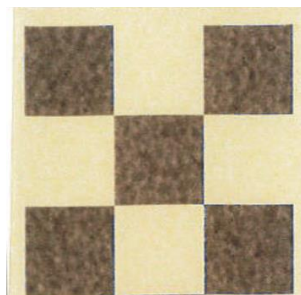
After
print



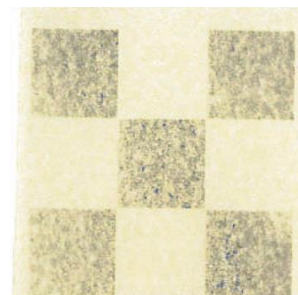
Heat and
Humidity



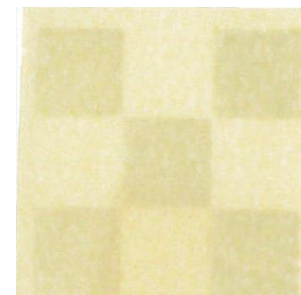
Dry Heat



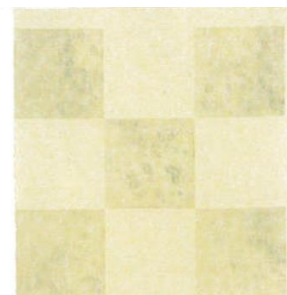
Fluorescent
light



Water

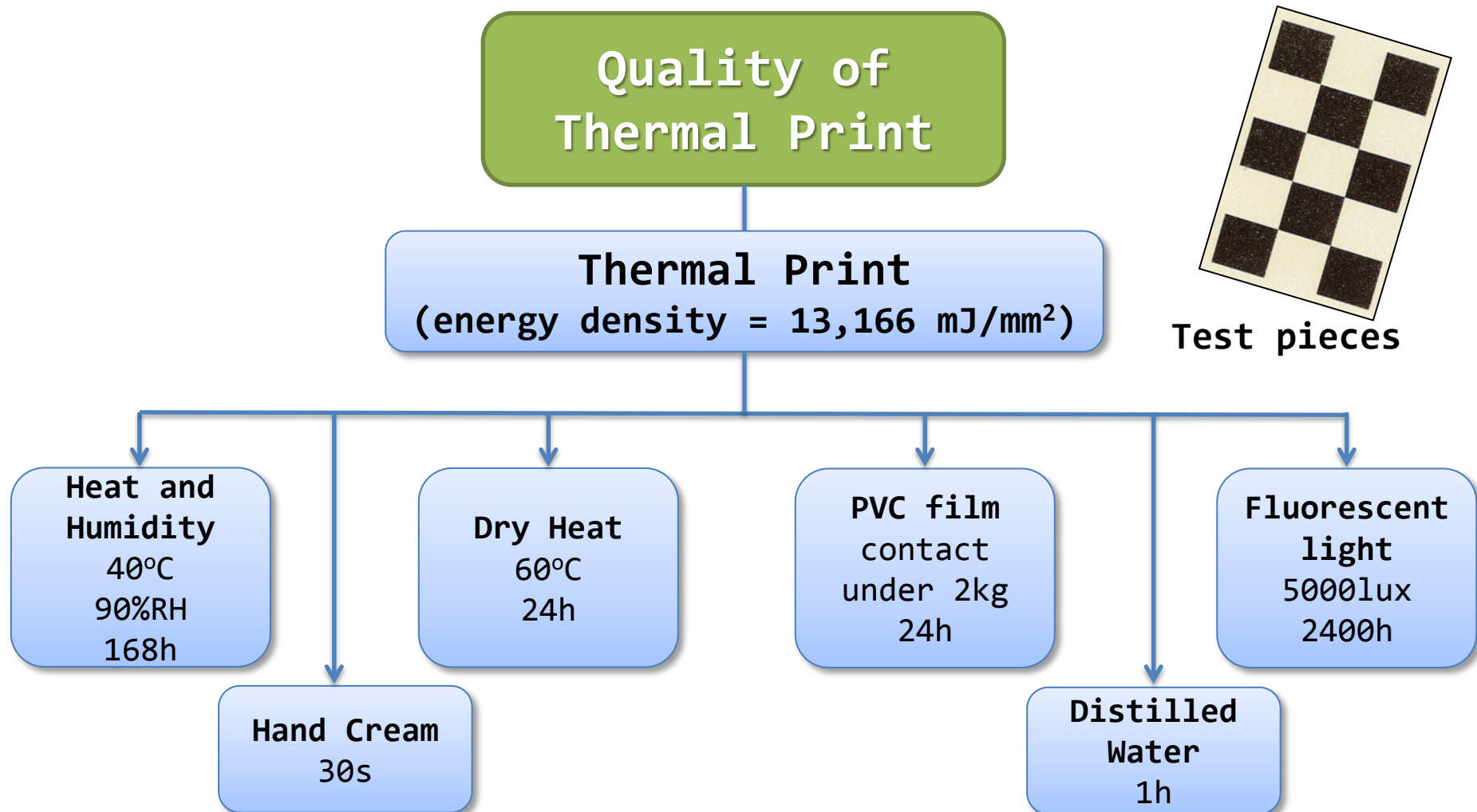


Hand Cream



PVC

Quality of Thermal Print





Quality of Thermal Print

Table 5 - Optical density results

Sample	Initial	Heat and Humudity	Dry Heat	Fluorescent light	PVC	Hand Cream	Water
1	1.24 (0.04)	1.24 (0.04)	1.25 (0.02)	1.13 (0.02)	1.24 (0.02)	1.27 (0.06)	1.08 (0.02)
2	1.36 (0.01)	1.23 (0.02)	1.31 (0.01)	1.30 (0.02)	1.36 (0.03)	1.40 (0.02)	1.08 (0.01)
3	1.34 (0.01)	1.34 (0.02)	1.37 (0.02)	1.30 (0.02)	1.31 (0.03)	1.38 (0.06)	1.20 (0.01)
4	1.32 (0.01)	1.26 (0.03)	1.26 (0.05)	1.25 (0.02)	1.27 (0.02)	1.32 (0.01)	1.05 (0.02)

Note: The results are average values and each number between brackets is the standard deviation of 25 determinations.

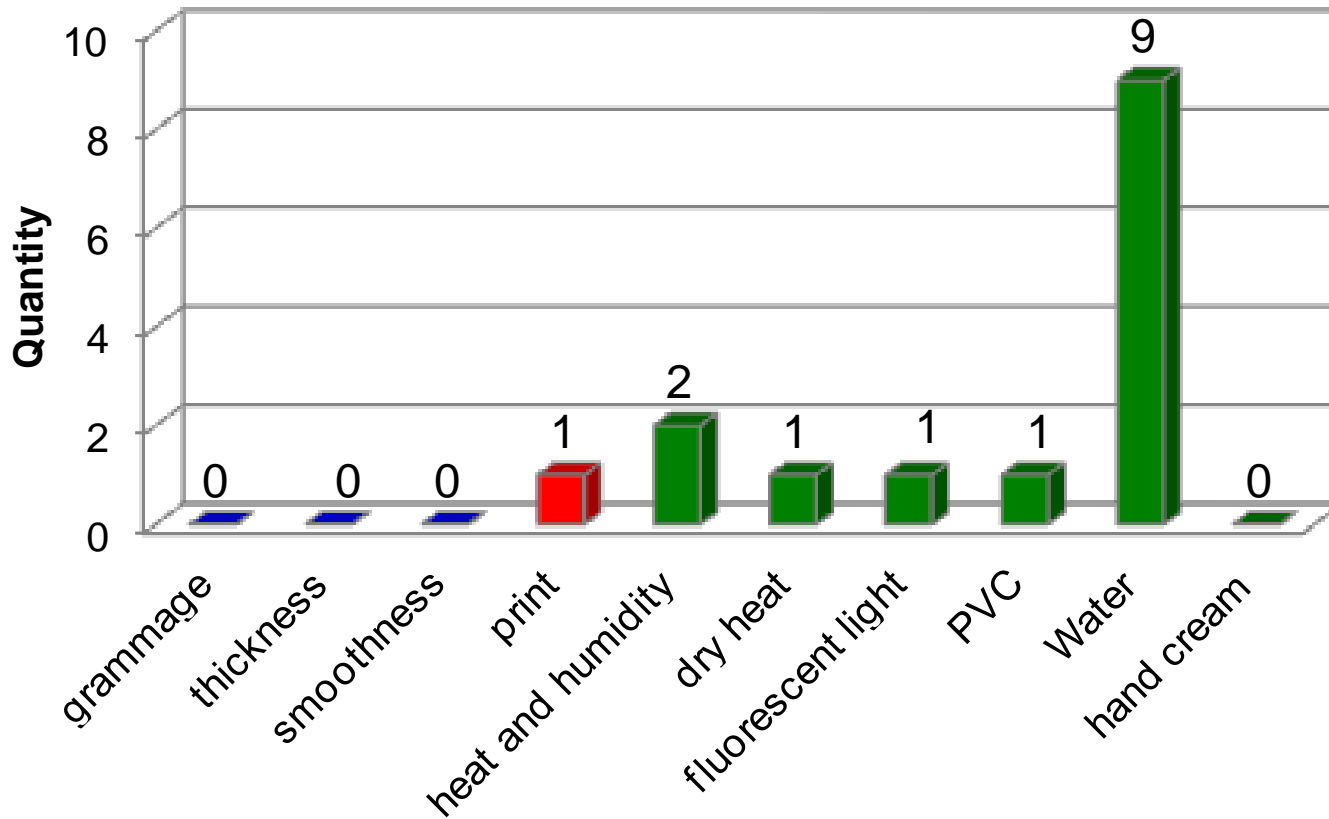
Table 6 - Requirements for optical density

Country	After print
Brazil ¹	≥ 1.00
Italy ²	≥ 0.60



Quality of Thermal Print

IPT Paper and Pulp Laboratory





Permanence of Print

**Brazilian Legislation
Fiscal and Financial Documents
Bank Information**



5 years

Castro, C.J.L.; Victorino, C.R.; Tobias, J.J. “Guarda e Manutenção de Documentos Fiscais”. 3ª edição com base na legislação em vigor em fevereiro de 2010



Permanence of Print

Brazilian Legislation:
Ato COTEPE ICMS n.4
(Mar 11th, 2010)



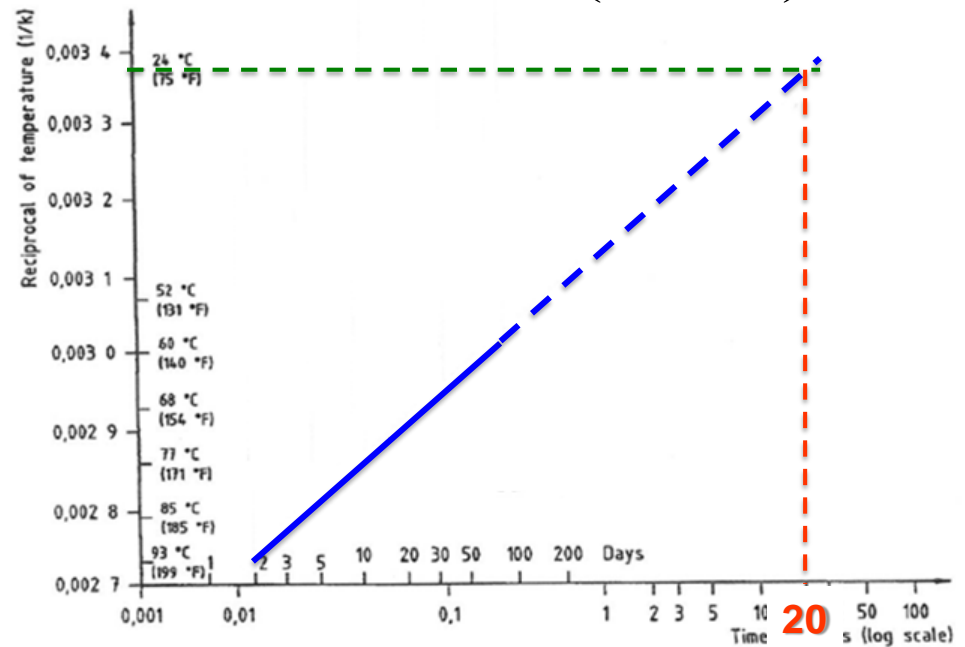
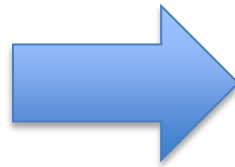


Permanence of Print

Accelerated Aging

$$\log k = \log A + \left(\frac{-E_a}{2.3RT} \right)$$

5 years





Permanence of Print

Technical Article / Peer-reviewed Article

O PAPEL vol. 74, num. 1, pp. 51 - 55 JAN 2013

DIFFICULTIES IN THE APPLICATION OF THE ARRHENIUS MODEL TO PREDICT THERMAL PRINTING LIFETIME

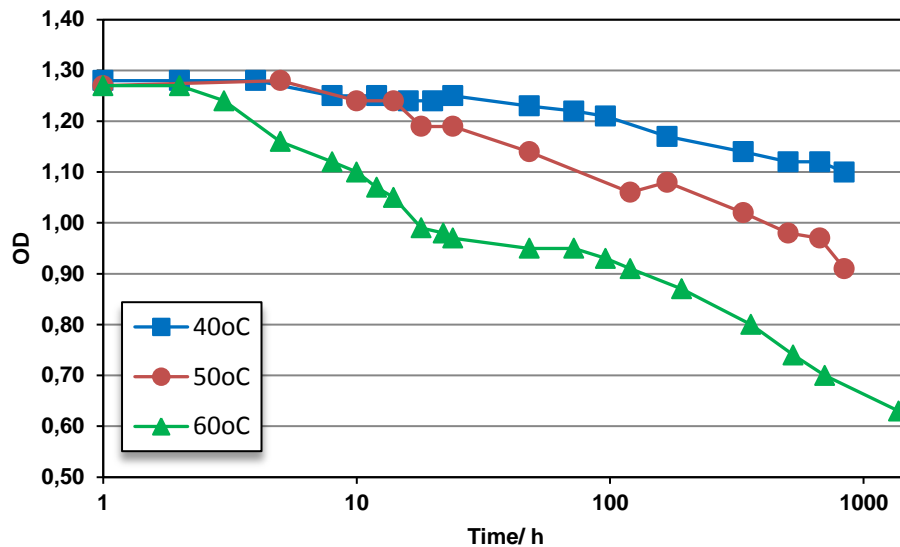
Authors*: Daniela Colevati Ferreira¹
Maria Luiza Otero D'Almeida¹

Permanence of Print

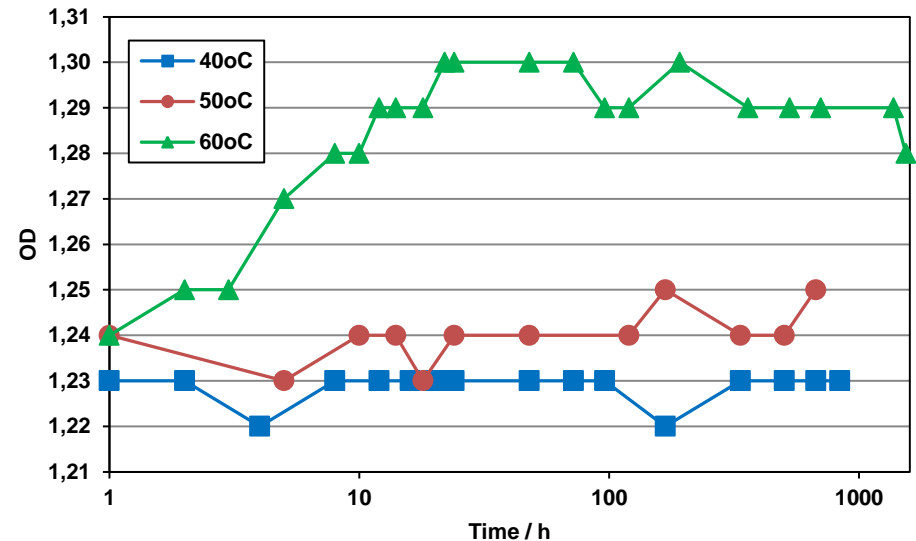
Accelerated aging models based on heat is not applicable to thermal paper

- Different paper = different behavior

“Paper F”



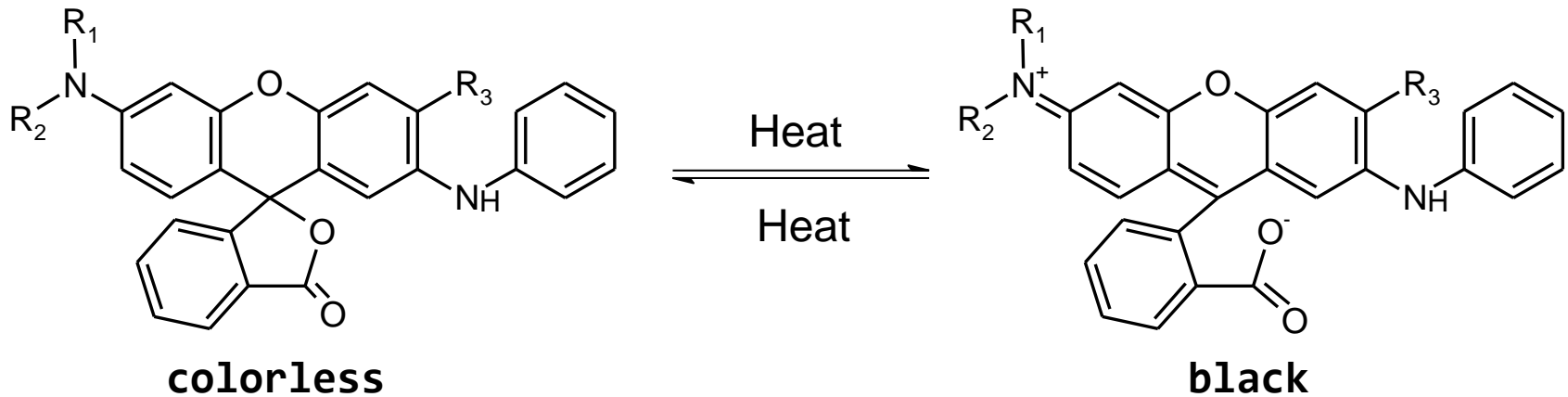
“Paper G”



Permanence of Print

Accelerated aging models based on heat is not applicable to thermal paper

- Competition between color formation and degradation





Permanence of Print

Manufacturers can predict the print permanence because they know the coating composition of their thermal paper.

Grade name	Recommended application	Grammage (g/m ²)	Thickness micron	Thermal printing		Image stability* years
				Dynamic sensitivity	Maximum density	
PRODUCT SELECTOR						
AP45KS-D		48	55	+++	+	7 Standard
AP45KS-FD		48	55	++	+++	10 Durable
AP45KJ-R		48	55	++	++	25 Extra durable



Conclusions

Brazilian Legislation:
Ato COTEPE ICMS n.4
(Mar 11th, 2010)

New limits





Acknowledgments



Associação Brasileira Técnica de Celulose e Papel





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