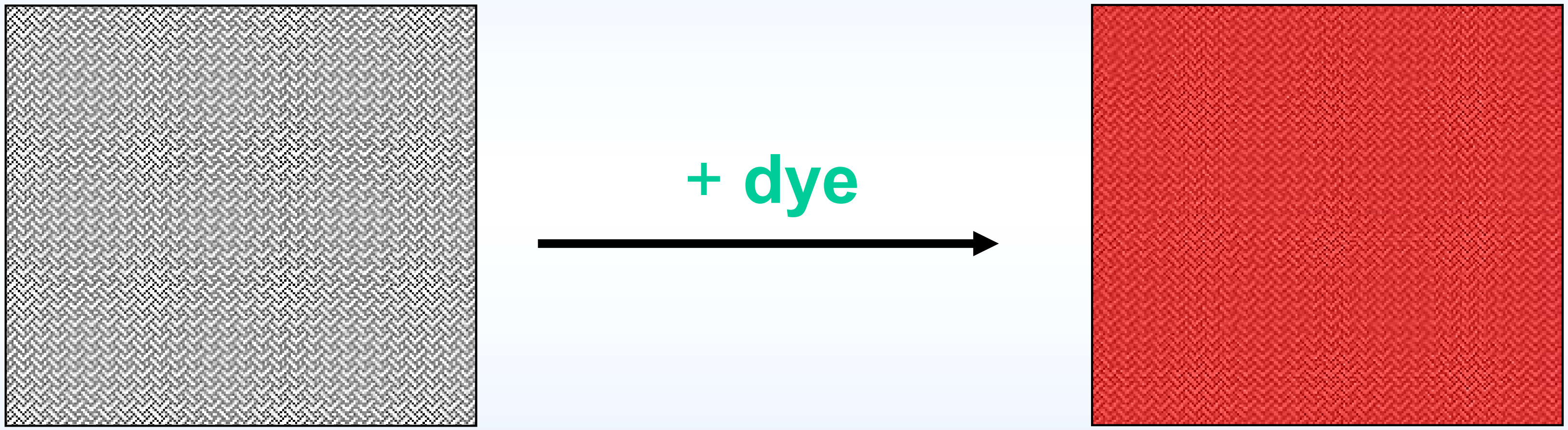
Textile Chemistry

10 coloration of textilies

Jakub Wiener

Dyeing



Dyeing

Technology:

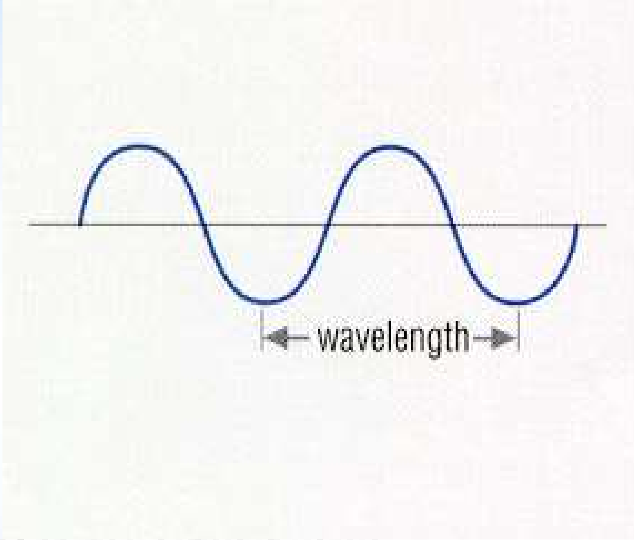
Selection of dyes, dyestuff application

Art (selection of problems):

Interaction with light, minimal damage by dyeing, prediction of color fastness, evenes of color …

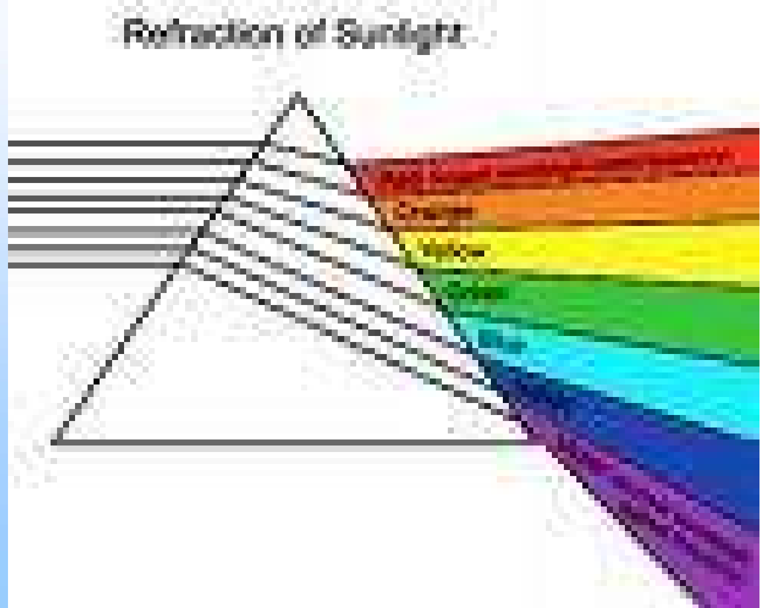
Light and color

light - stream of photons having different energy E (unit: Joule)



Planck equation describes relation between energy of photons frequency and wave length

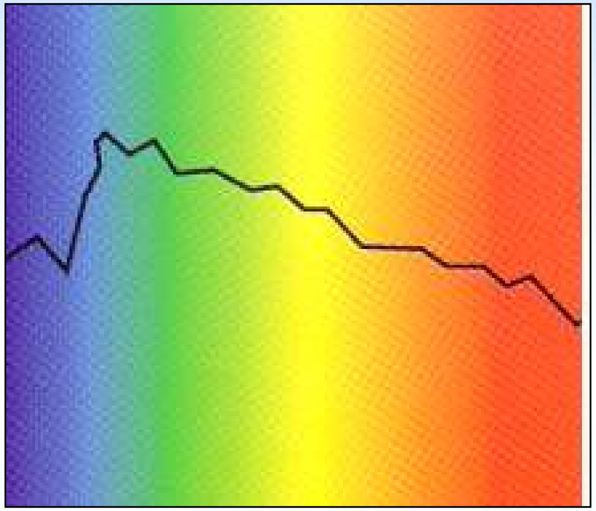
$$E = h.\nu = \frac{h.c}{\lambda}$$



h ... Planck constant (6,6.10^{-34} J.s)
ν ... light frequency (s^{-1})
C ... velocity of light in vacuum (3.10^{8} m.s^{-1})
λ ... wave length (m)

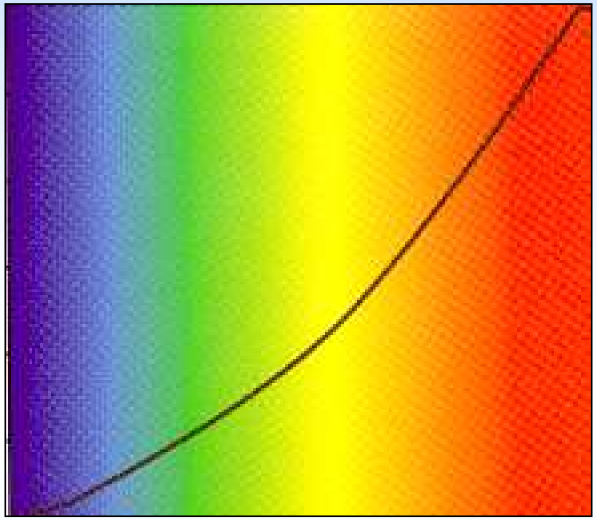
Light sources

Daylight

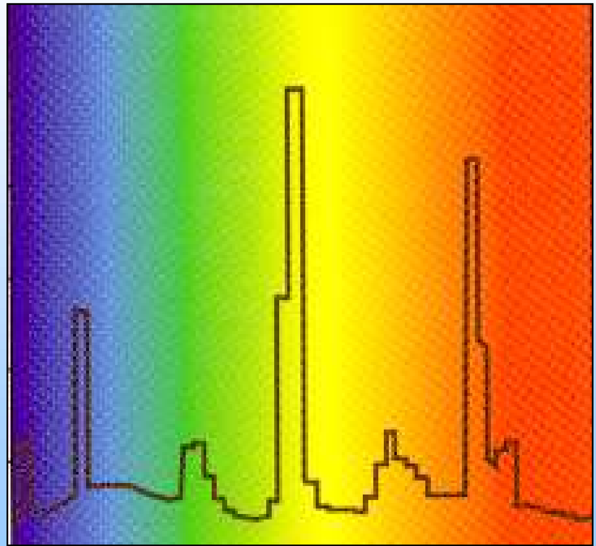


Tungsten bulb

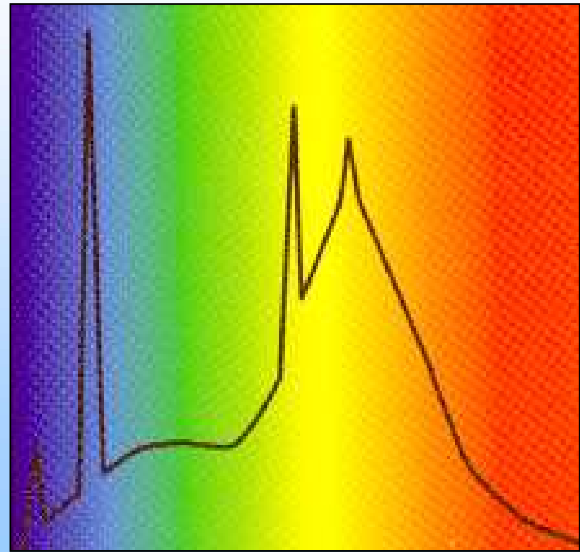
Domestic Light



TL84
Store Light



CWF
Store Light



Dyeing

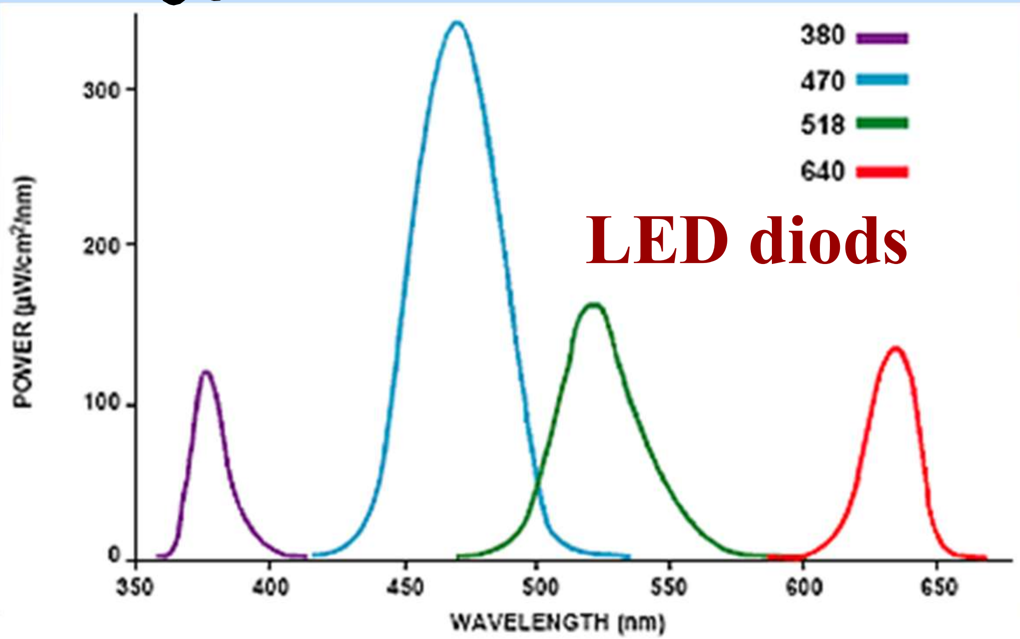
Daylight is a white light which is slightly bluish, but emits a good proportion throughout the visible spectrum. It is a good light to observe all the colours within the visible spectrum. It also has UV emission.

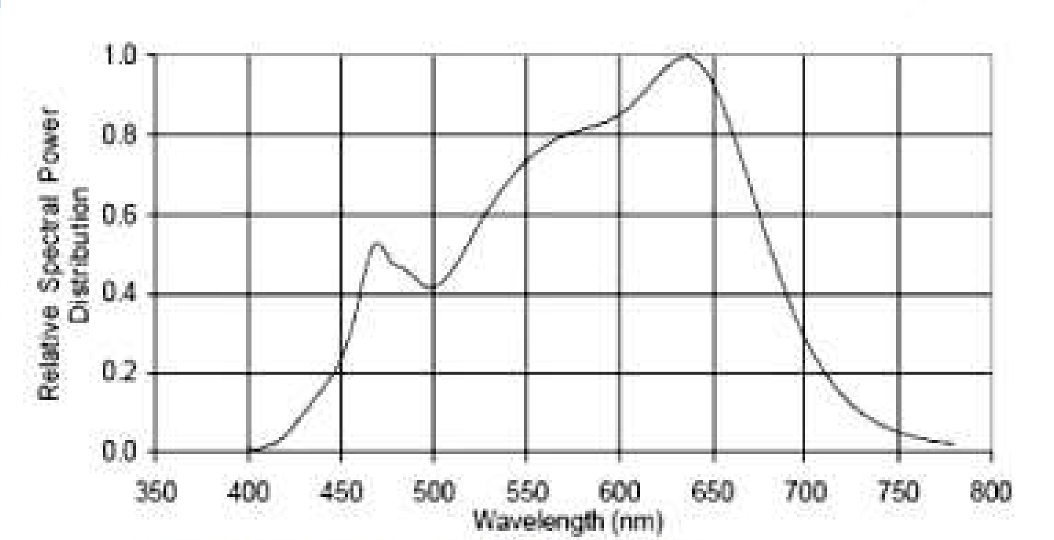
Domestic light has it's energy content at the red end of the spectrum with very little at the blue end, it is seen as a very reddish light. It is difficult to assesses differences in very dark shades especially between blacks and navy blues.

TL84 is a fluorescent lamp using three phosphors in the red, green & blue parts of the spectrum deliberately designed to match the eye's RGB cones. The deficiency of this light is in the yellow region so the stores often use spotlights (Tungsten) to illuminate gold jewellery.

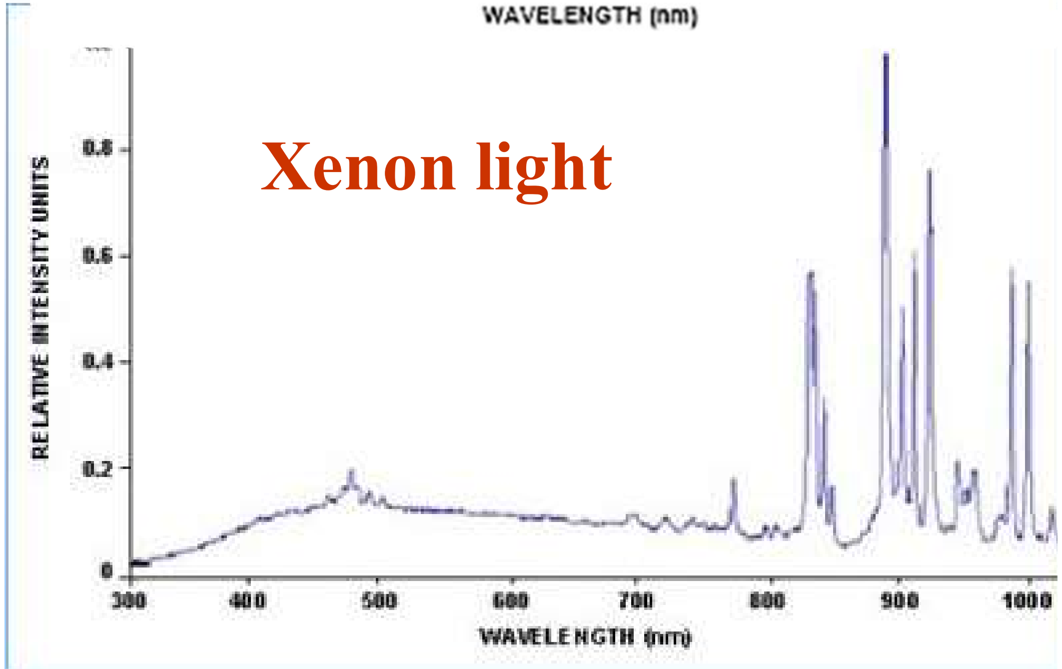
Cool White (CWF) is used predominately in in the USA for both stores and offices. There are three peaks in the blue, green and yellow. There is a low emission in the red region. A bright orange will therefore be seen as a flat yellowish shade.

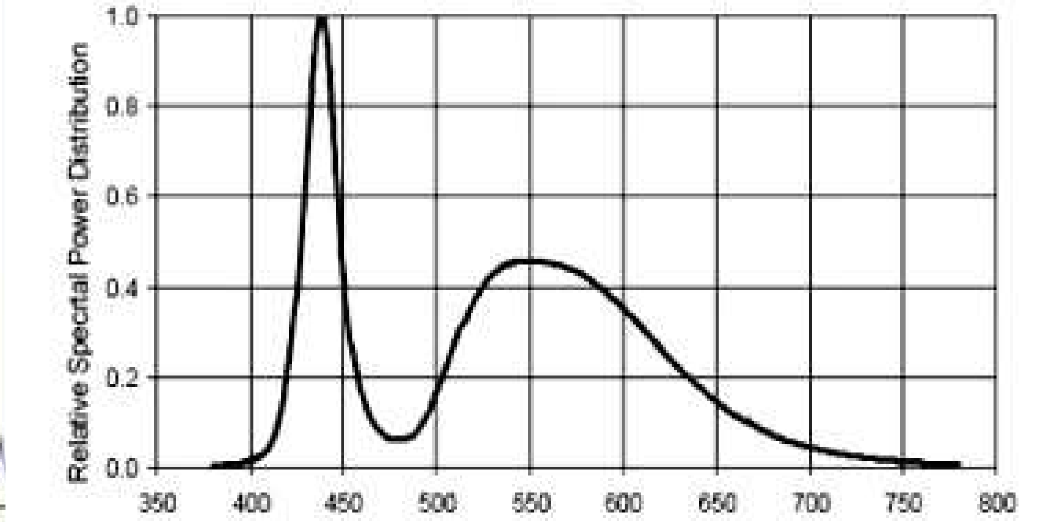
Light sources





Typical Warm White Color Spectrum





Typical Cool White Color Spectrum

Spectrophotometry

In contact with matter can be selective absorbed energy of light – the light spectrum is changed.

These spectral changes can be sometimes observed visually (if is absorbed visible light). In all cases are the changes measurable by spectroscopy/spectrophotometry.

Spectrophotometry = light intensity measurement at selected wavelenghts

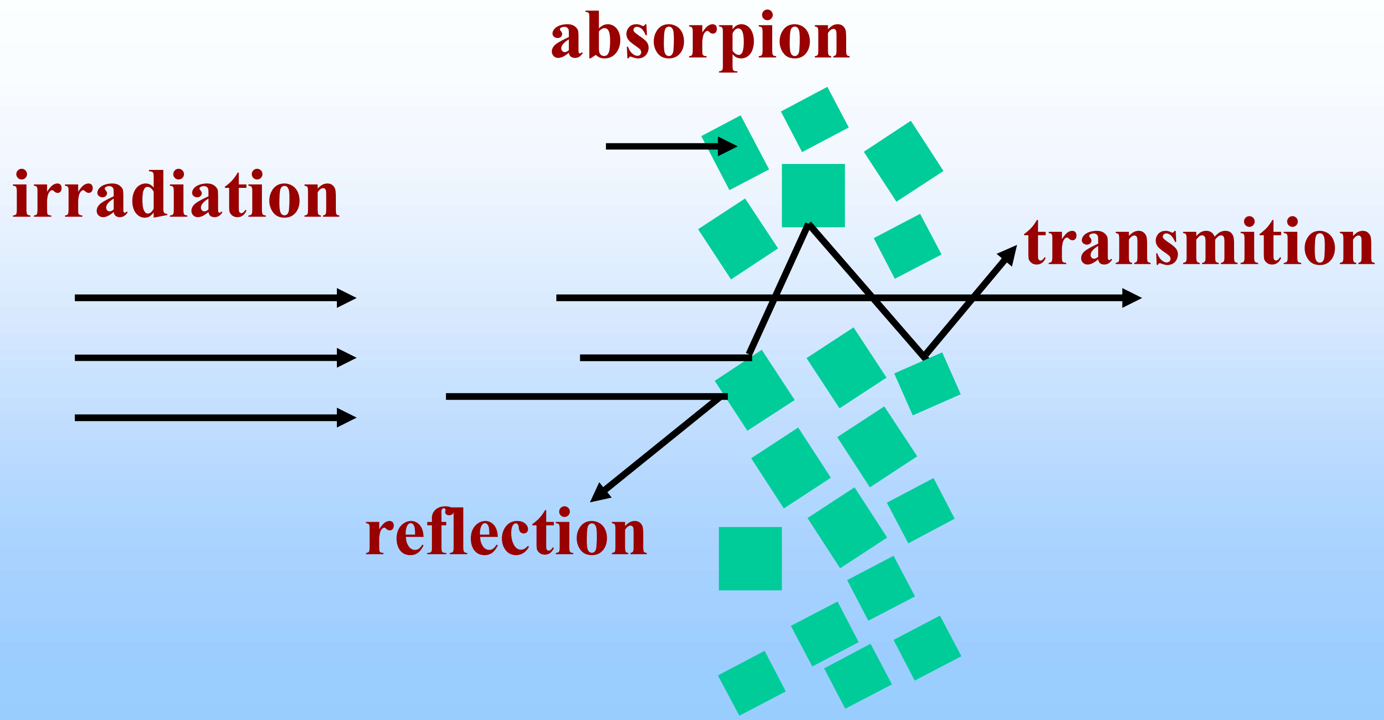
The changes of light are serious in practical live – the ozone layer around of earth, the color of textiles, identification the used dyes in textiles...

Spectrophotometry

changes of light spectrum and direction are based on:

Reflection (some parts of light will be reflected) – on roughs surfaces with high refraction index (diamond, titanium dioxide...)

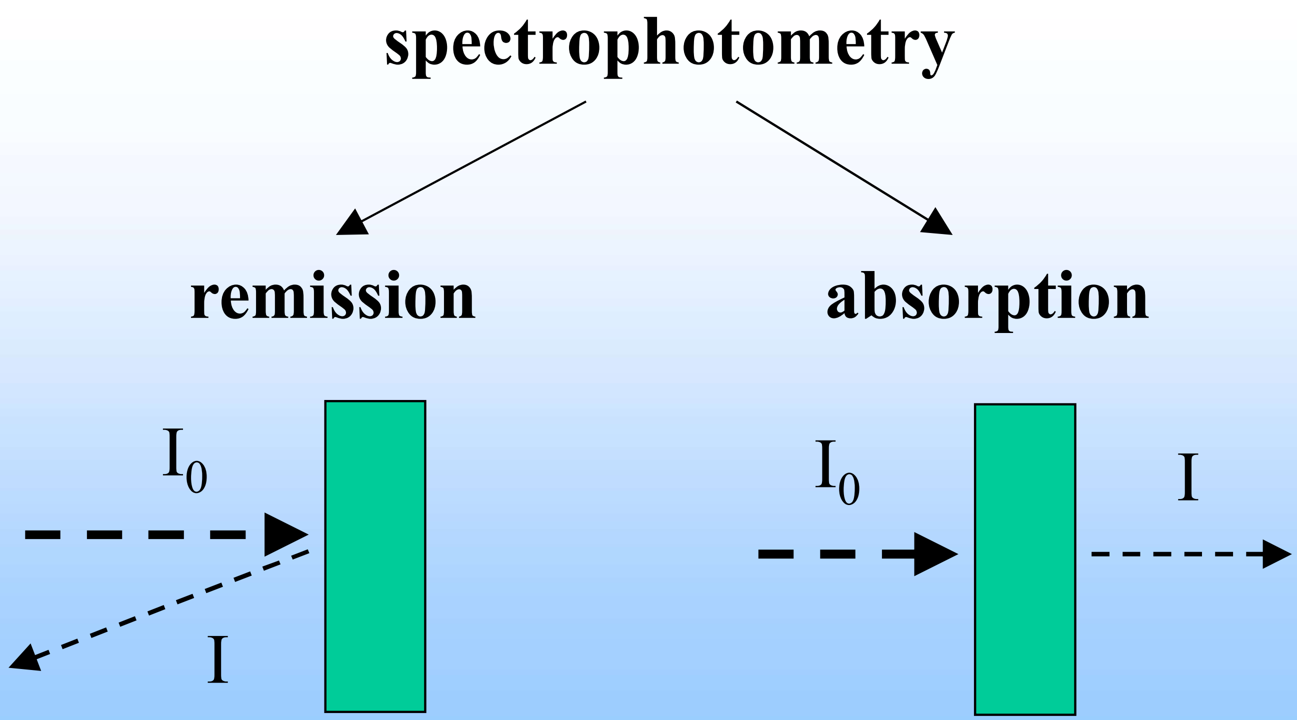
Absorption (some part of light will be absorb) – on natural or synthetic dyes, special molecules (conjugated double bonds)



Spectrophotometry

<u>remission spectrophotometry</u> - solid objects, registered is reflected light, *color measuring* of textiles

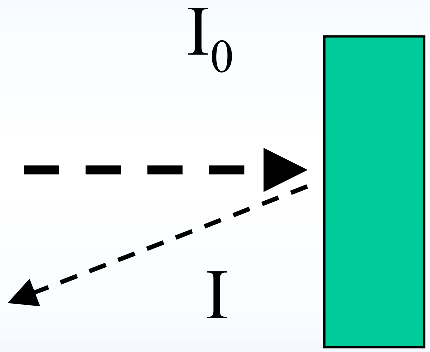
<u>absorption spectrophotometry</u> – solutions, films, gases - dye-solutions



Kubelka – Munk equation

Remission spektrophotometry

$$R = \frac{I}{I_0}$$

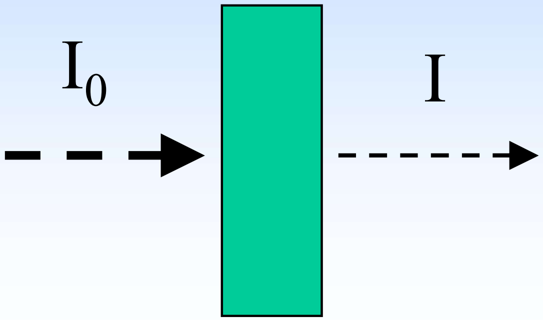


$$\frac{(1-R)^2}{2.R} = a.C$$

Reflected light is measured

For textiles, pigments, nontransparent solids…

Lambert – Beer equation



Transmitted light is measured

For liquids, films, gases…

$$A = -\log\left(\frac{I}{I_0}\right) = \varepsilon . d . c$$

$$T = \frac{I}{I_0} . 100\%$$

A … absorbance (non-dimensional)

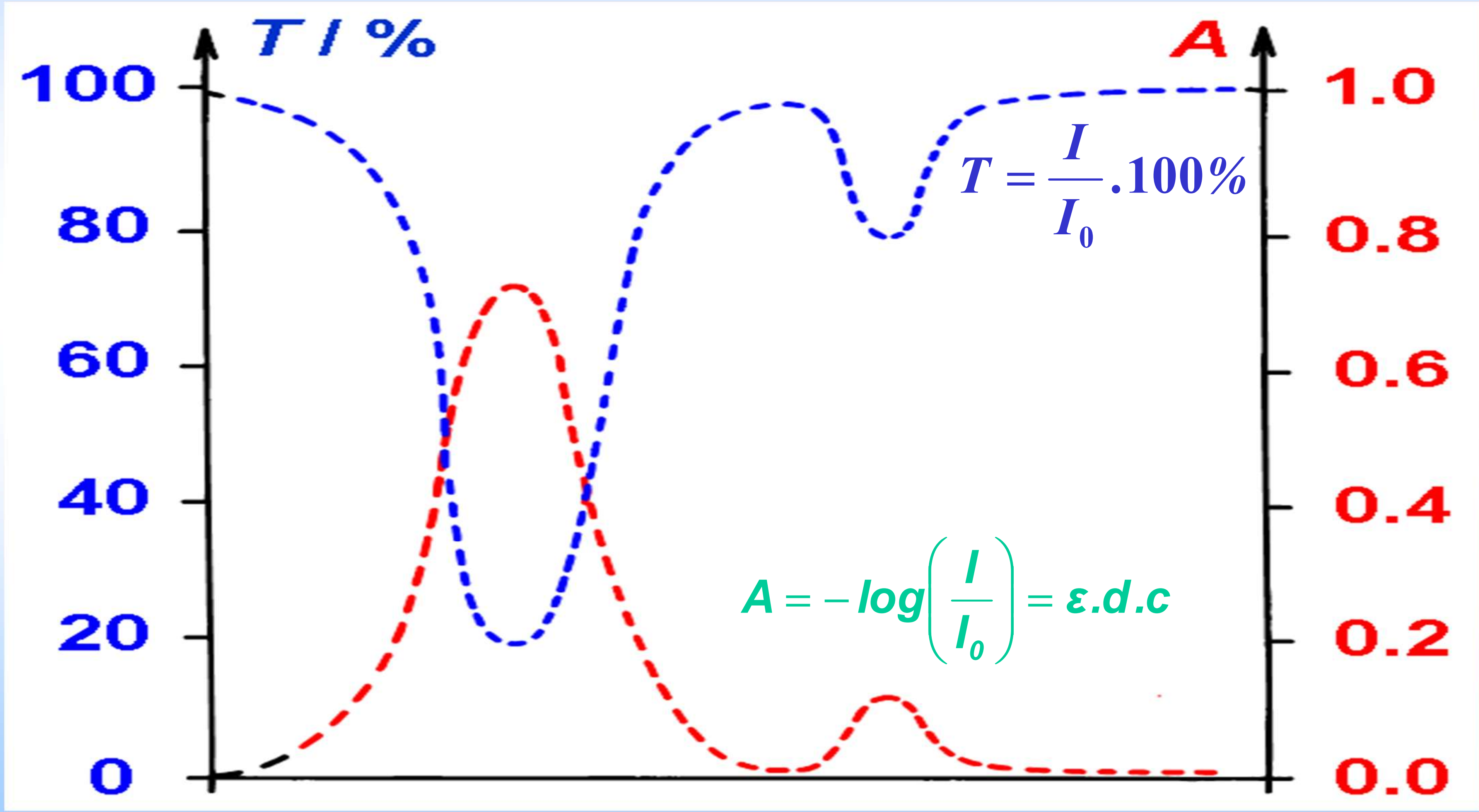
ε … absorption coefficient molar (mol.l^{-1})
or special (g.l^{-1})

c… concentration of dye in solution (mol.l^{-1})
or (g.l^{-1})

d… thickness of absorbing layer of a solution (cm) in measure cell

Dyeing labs: Estimation of dyestuff concentration before and especially after dyeing (to estimate dyestuff „exhaustion“

Lambert – Beer equation



380 nm

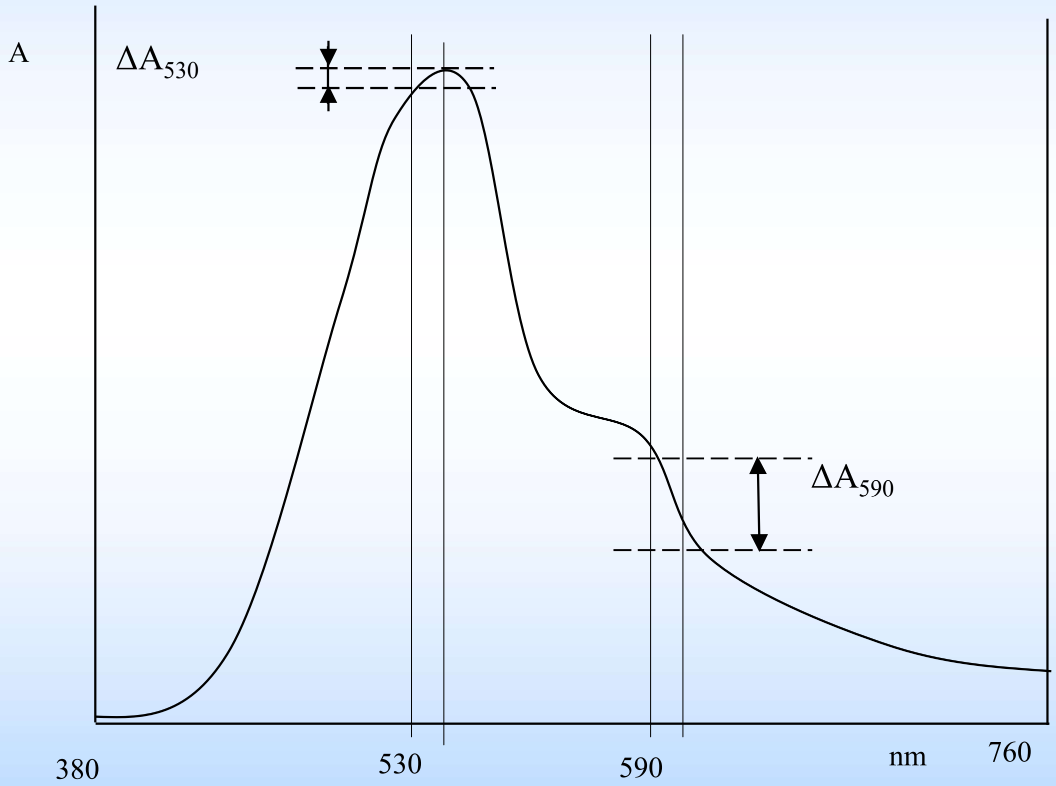
760 nm

Lambert – Beer equation

Determine the A in absorbance maximum – wavelength of given dye !

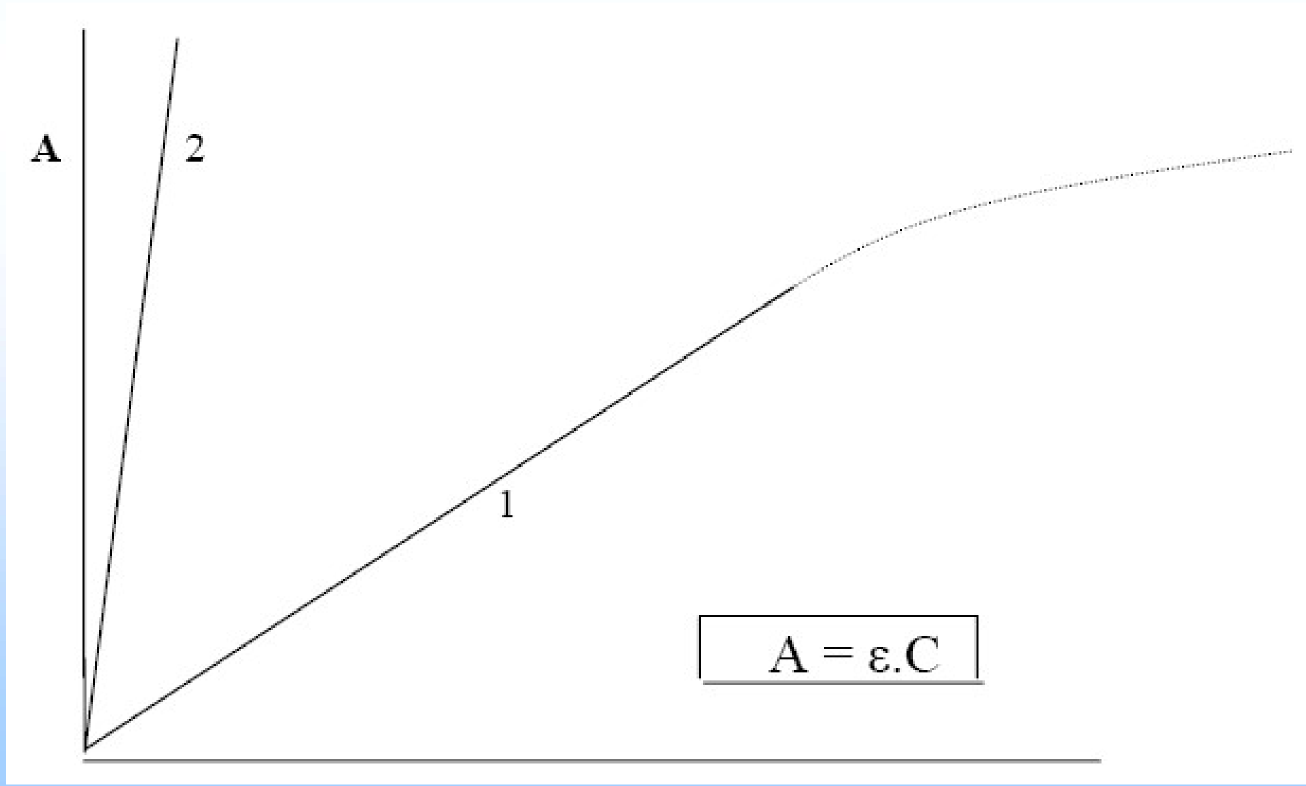
- Is possible estimate the smallest concentrations

- Mistakes based on wrong setting of wavelengh at spectrophotometr are minimal because the spectral curve is smooth

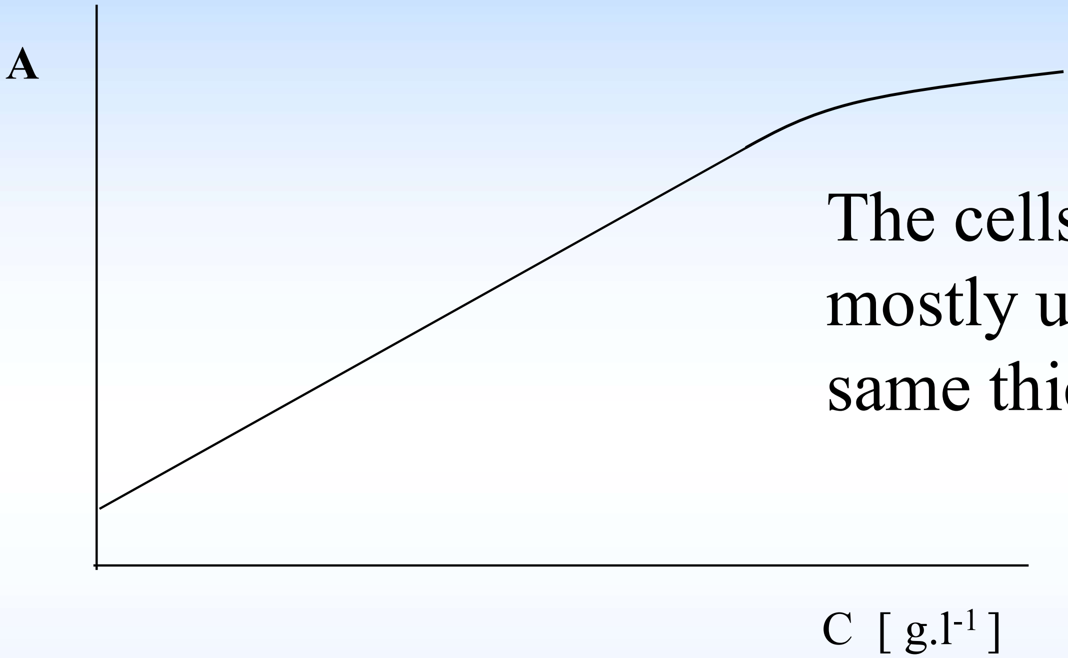


Lambert – Beer equation

The absorption coefficient ε represents the color strength of dye :
“stronger” dye (2) yields higher ε than dye (1)



Lambert – Beer equation



The cells (cuvette) are mostly used with the same thickness 1cm

deviation from linear dependence by concentration:

recommended concentration of common dyes about 10 mg/l !

the A-values shouldn't be greater than 0,6 – 0,7 (at higher concentrations are dyes more aggregate and its changes the spectral characteristics and we are limited by spectrophotometer construction (higher values of A are not save)

Lambert – Beer equation

Practical advances for measuring:

<u>* Absorbance A is influenced</u> by pH, salts, concentration and type of auxiliaries – by all compared solutions this aspects must be the same

<u>* Solutions must not be fluorescent</u>

<u>* Solutions must not be turbid</u>

Spectrophotometric measurement of dispersions is not exact, certain results are obtainable by dilution by an essential amount of a solvent of disperse dyes that are also soluble in water (Dimethylformamide, Acetone, Ethanol)

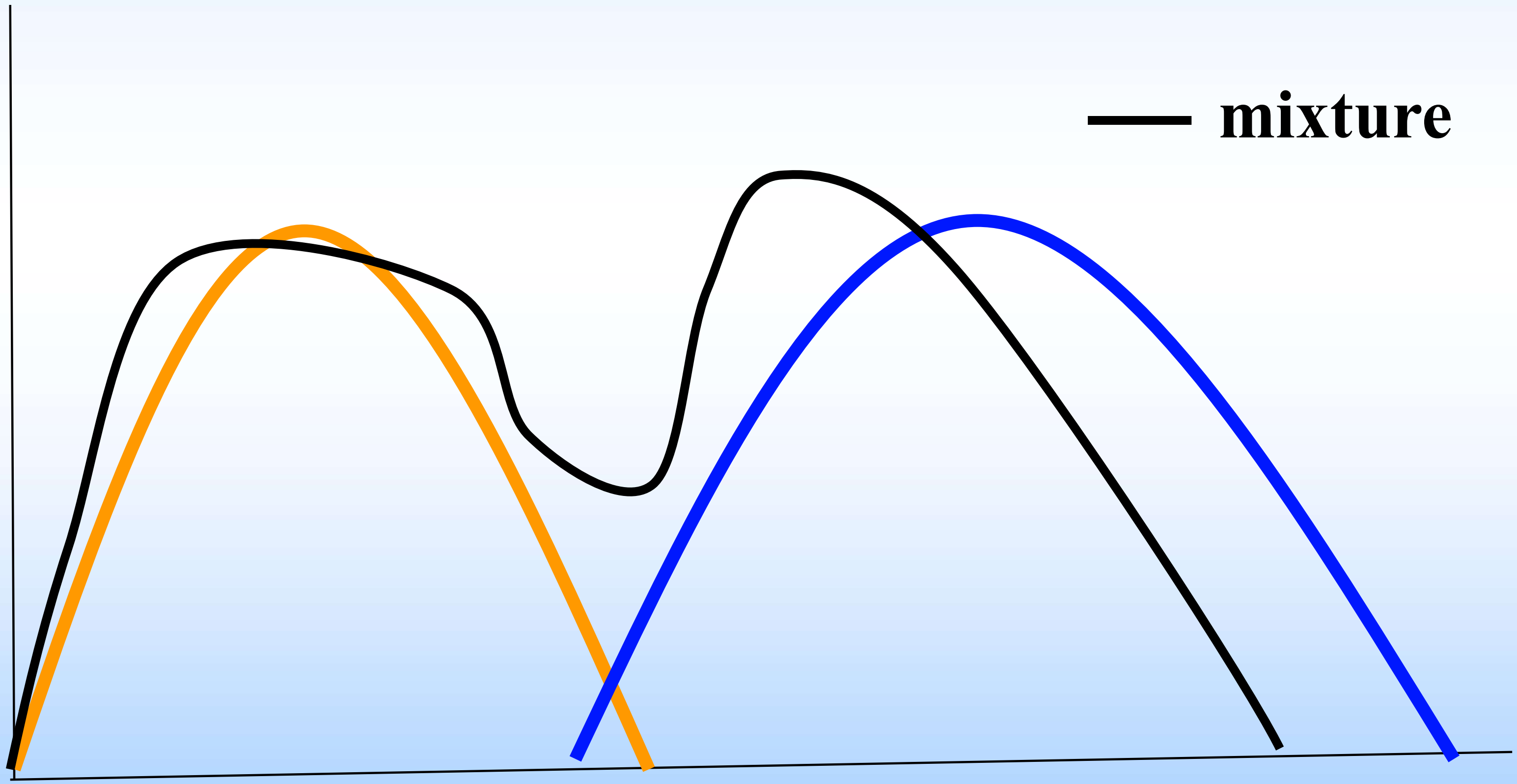
<u>**Other mistakes**</u>:

Broken of dirty cells

Air bubbles in liquor

Lambert – Beer equation

Nonaditive spectra – 2 or more dyes in one liquor = problems

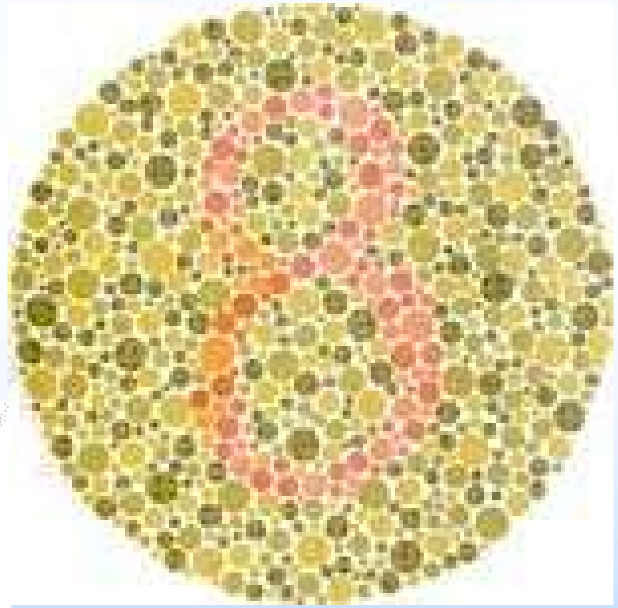


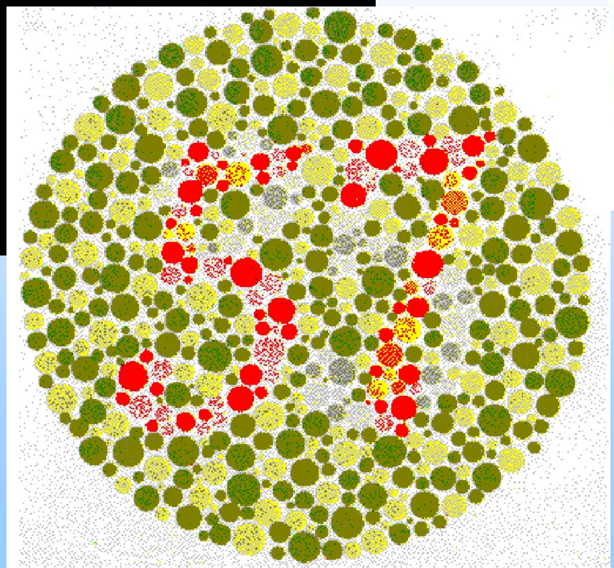
Reason: complicated aggregates

Solving: Software (neural networks)

Theory of color

Average human eyes detect light with wavelength between **380 – 760 nm.** The eye sensitivity decrees fluently to zero.

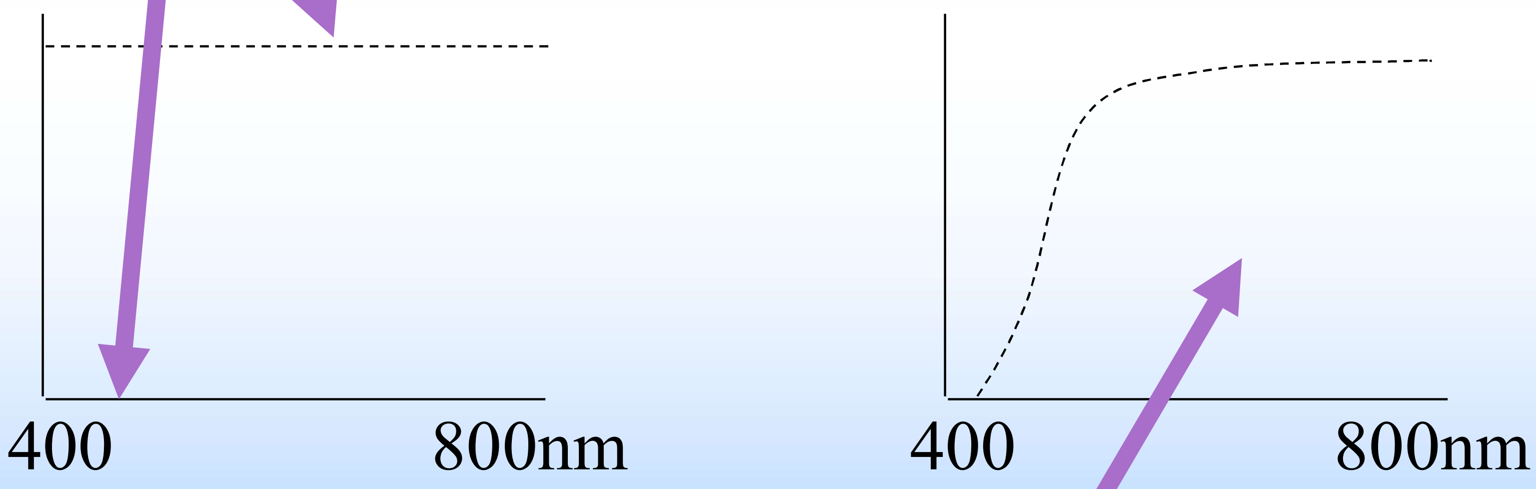




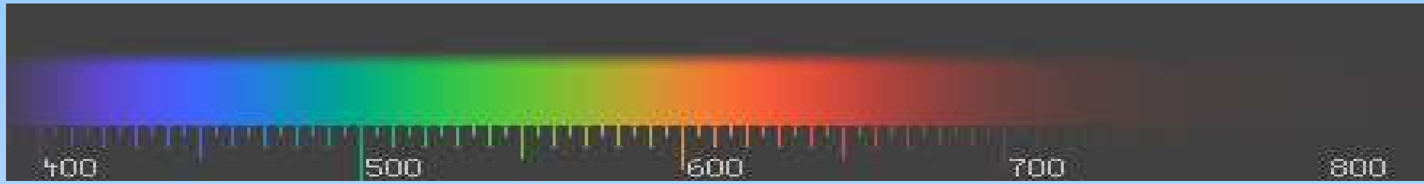
Theory of color

White color – intensity of light ist the same at all visible wavelenghts

Black color – the intensity of light ist zero at all visible wavelenghts



If are the photons of visible light selective absorbed (for example by the way trough the color liquor or though the textile fibers), than is observed other (varied) colors such as yellow and red.



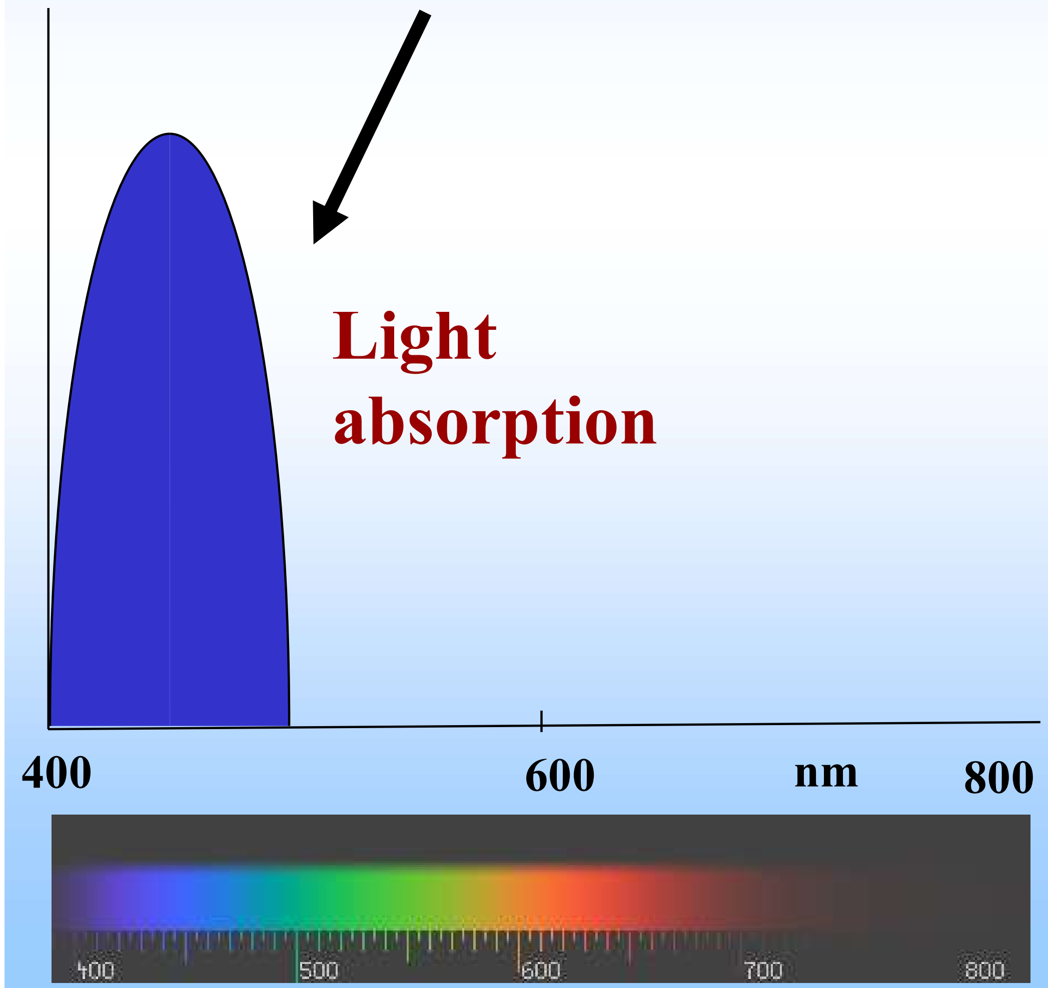
Absorbed rays (light)		Observed (complemental) color	Energy of photons $J.mol^{-1}$
Wavelenghts [nm]	Spectral color of light		
< 380	colorless UV-rays		> 300 000
380 - 435	violet	yellowgreen	300 000
435 - 480	blue	yellow	
480 – 490	greenblue	orange	
490 – 500	bluegreen	red	
500 – 560	green	purple	
560 – 580	yellowgreen	violet	
580 – 595	yellow	blue	
595 – 605	orange	greenblue	
605 – 730	red	bluegreen	158 000
730 – 780	purple	green	
> 780	colorless IR-radiation		< 158 000

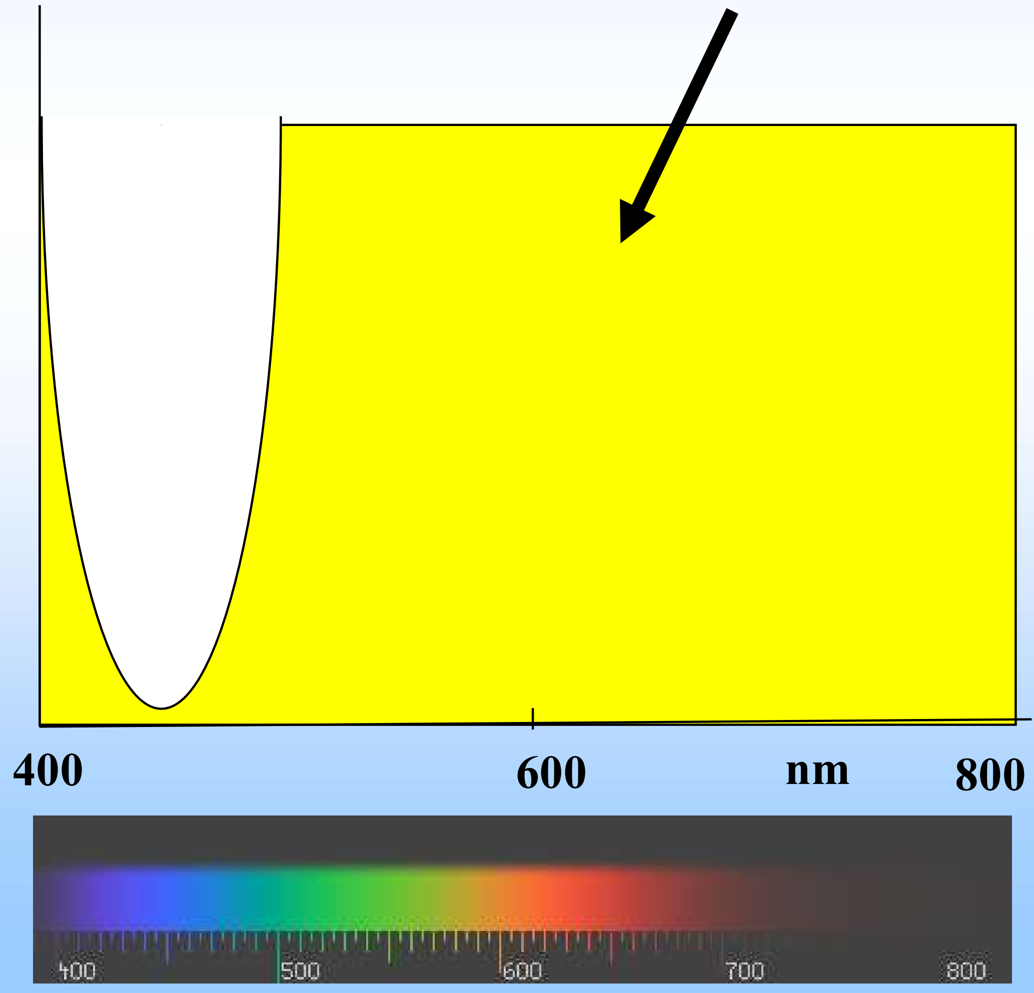
Theory of color

Observed (complementary) color

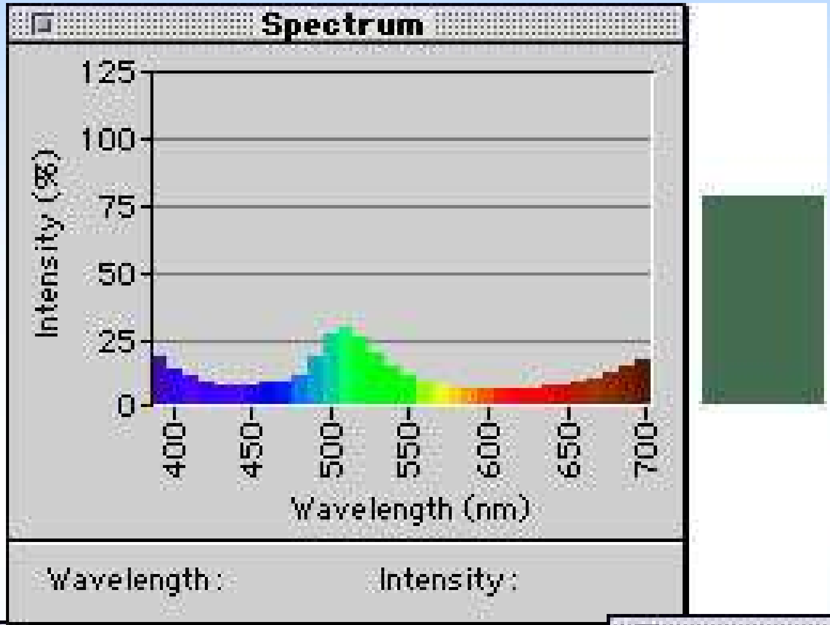
Sample:

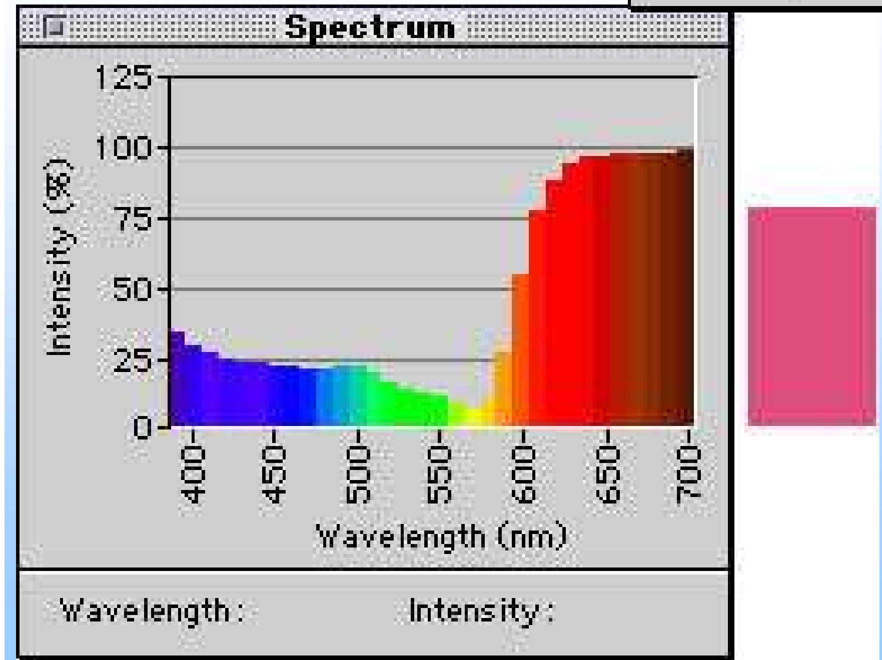
blue light is absorbed – the rest of spectrum is observed as a yellow color

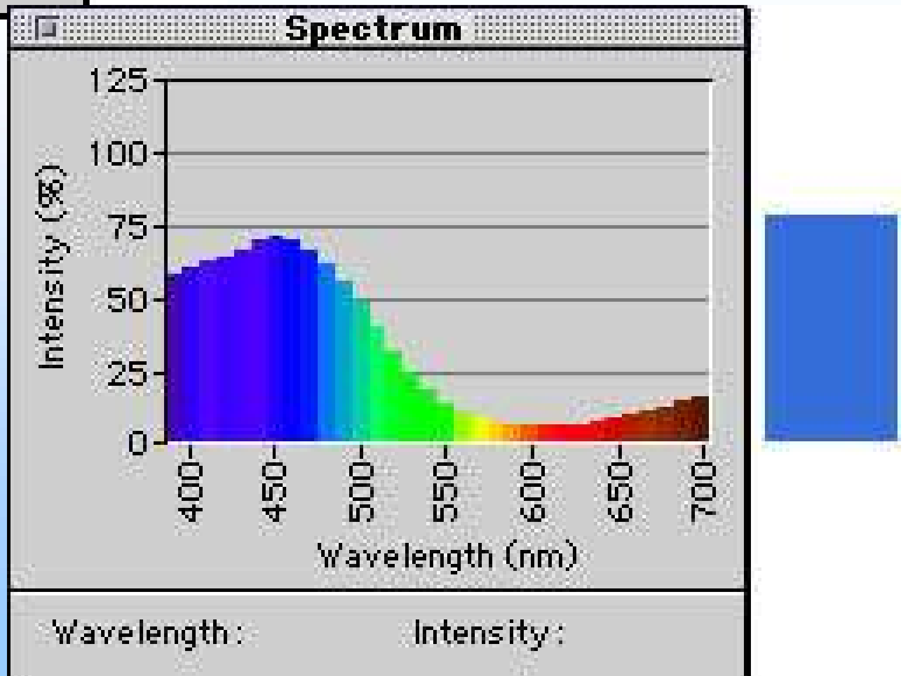




Theory of color





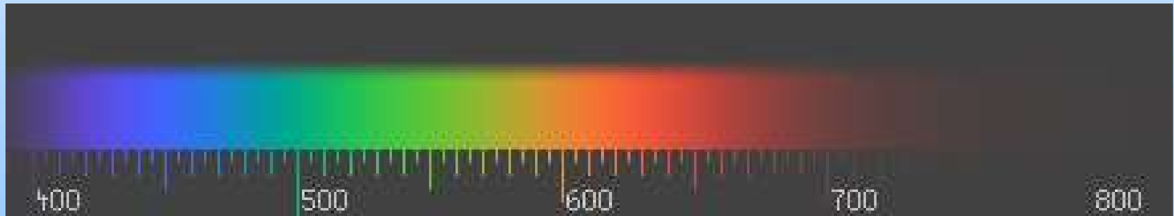


Theory of color

Energy of **visible** light from 158 000 to 300 000 J.mol^{-1}
Energy of **UV** light more then 300 000 J.mol^{-1} (more danger)
Energy of **IR** light les then 158 000 J.mol^{-1}

Colorless substances can absorb light from invisible parts of light - **I**nfra**R**ed (**IR**) or **U**ltra**V**iolet (**UV**)

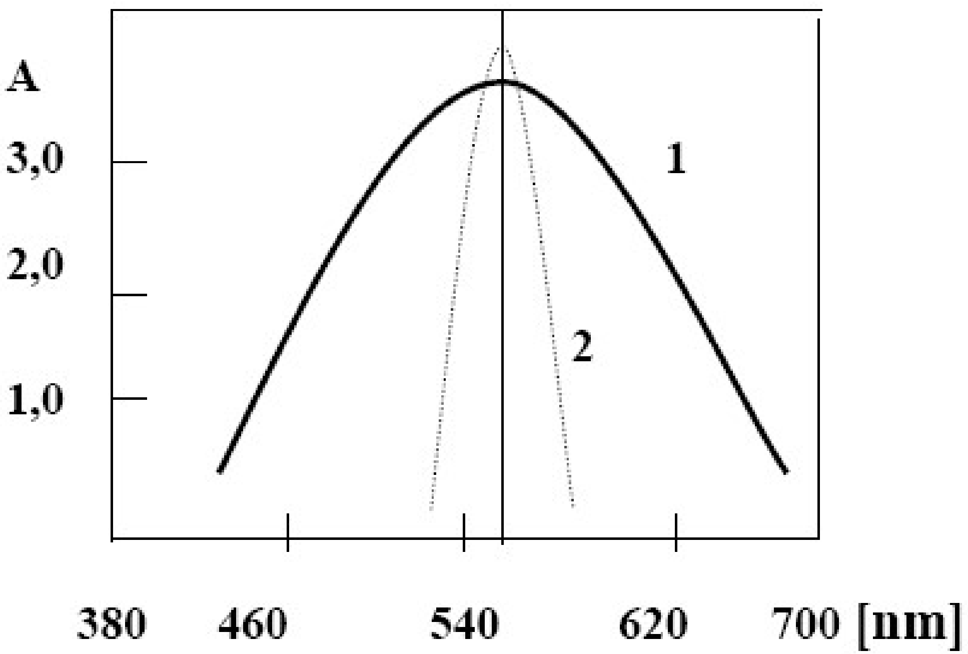
Real textile dyes absorb light in many wavelenghts trough all spectrum (UV and IR light).

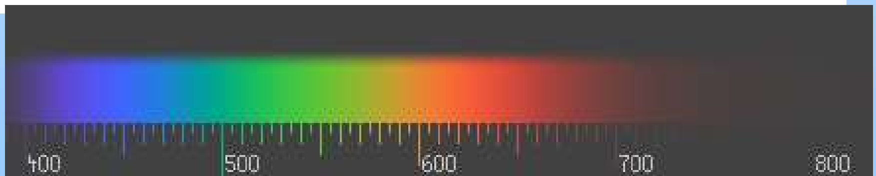


Theory of color

From measurement of A by all wavelengths of visible spectrum → spectral curves,

Sample: two spectral curves of two violet dyes which have the same absorption-maximum in yellow-green area:





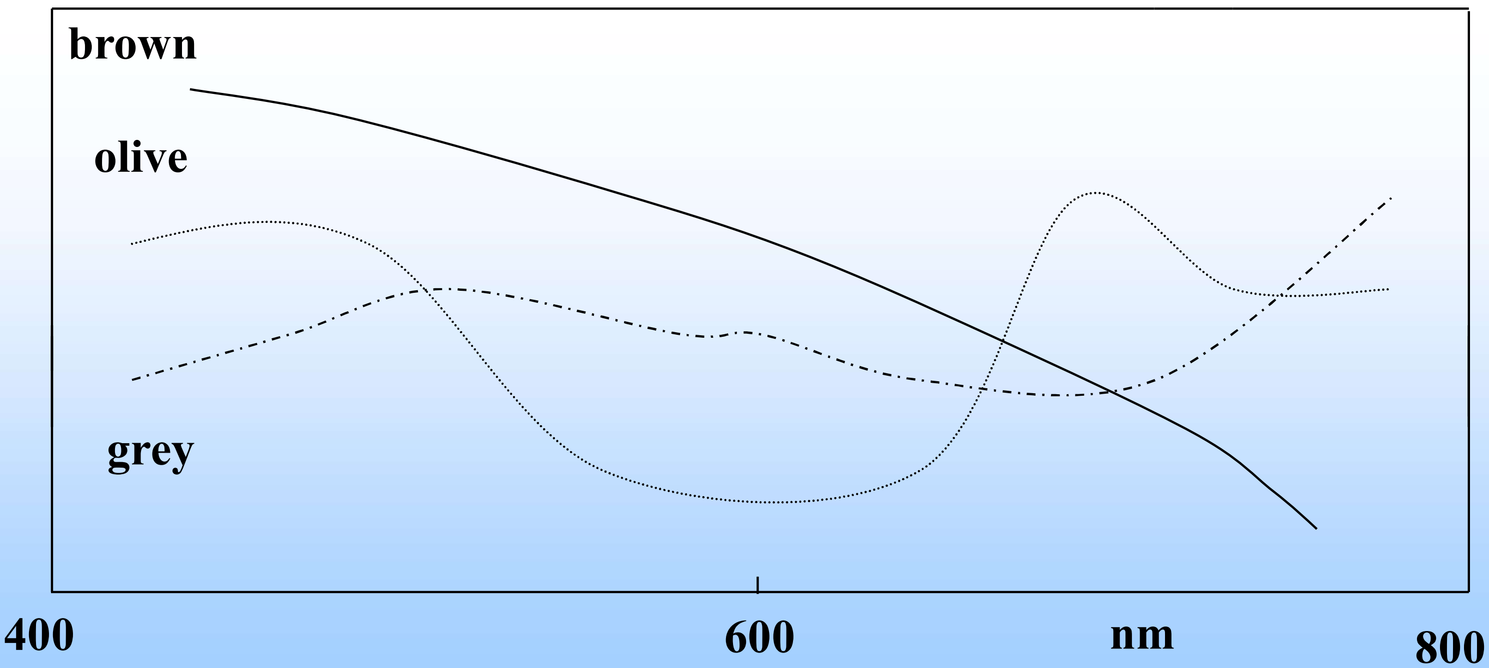
Curve 1 – the absorption takes place also in a wide range of spectral areas in neighborhood of absorption maximum. The shade is “flat” (not brilliant).

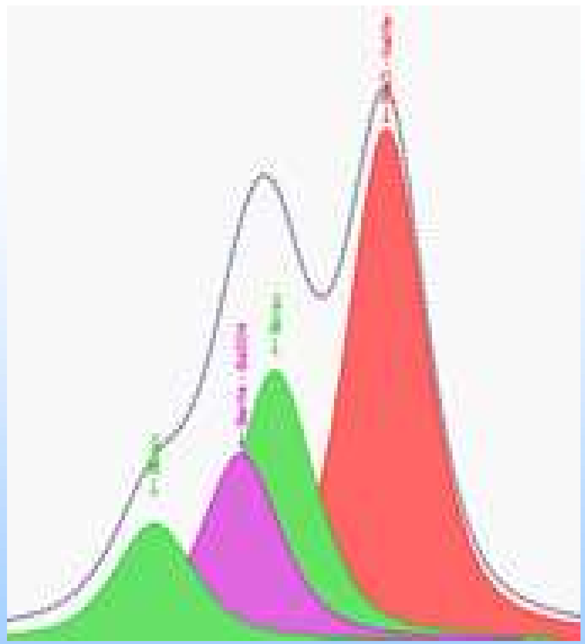
Curve 2 – is “sharper” = only a minimum absorbance by wave lengths out of absorption maximum. The shade is “clean“ (brilliant).

Theory of color

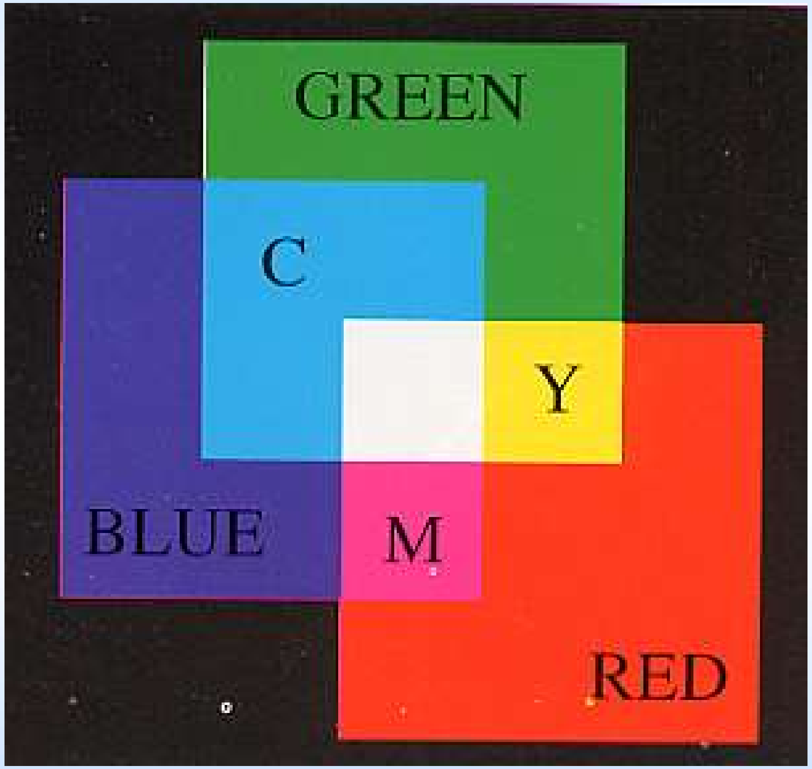
Spectral absorption curves of real common colors: browns, greys, blacks, olives and other flat shades

They have not typically more significant “maximums”





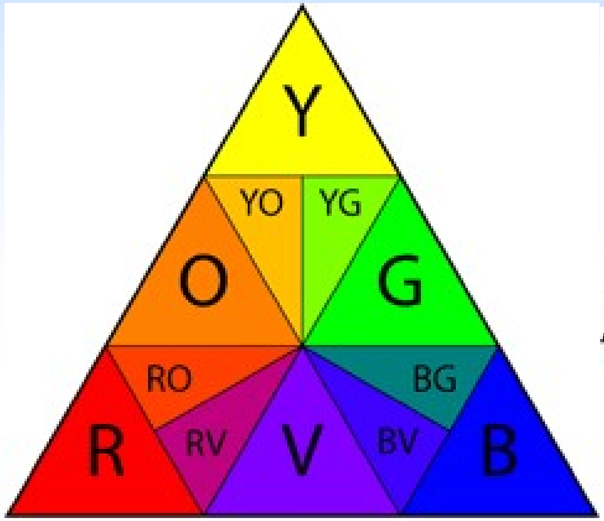
Color measurement RGB

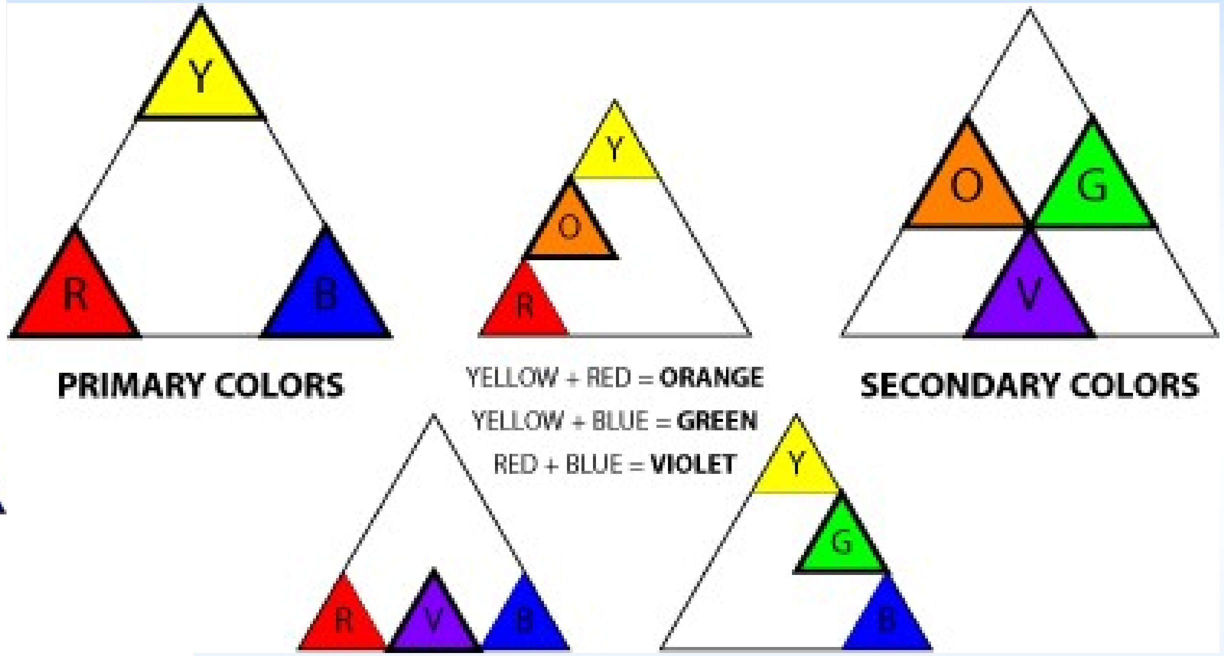


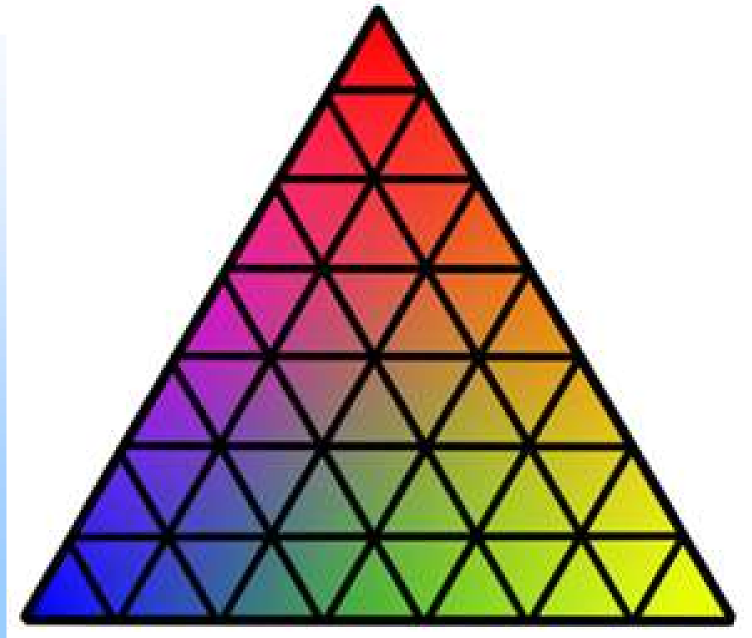
Aditivne mixing

Subtractive mixing

Theory of coloration







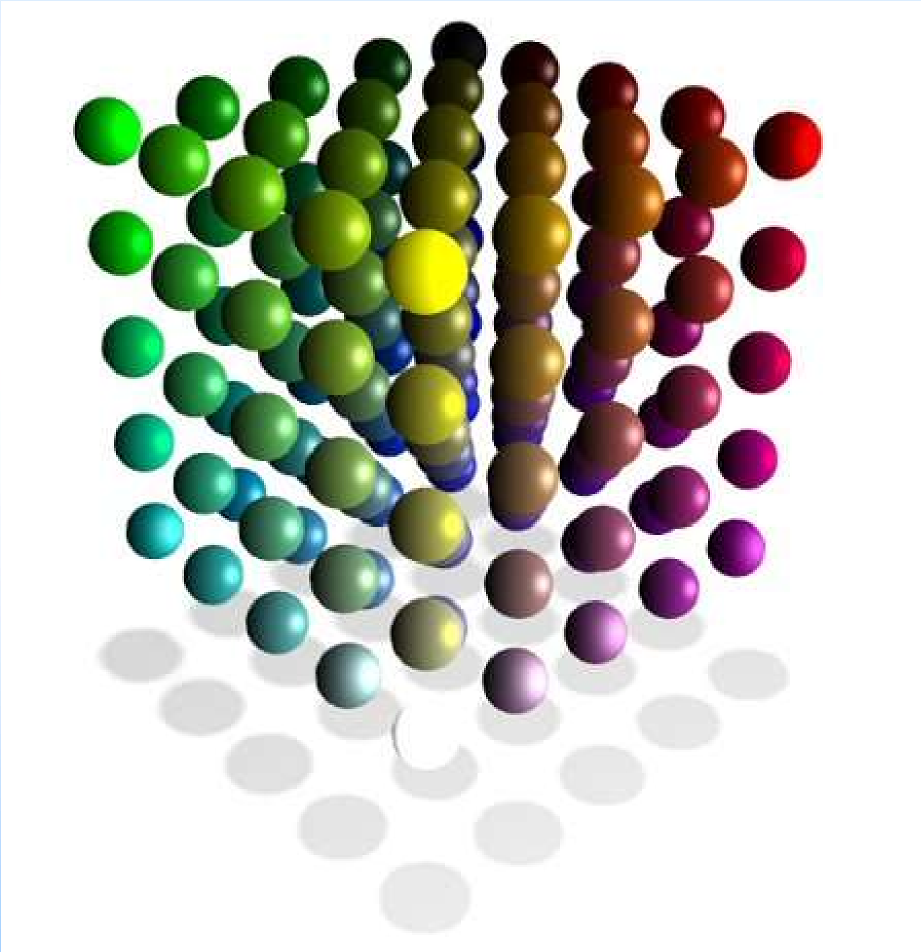
Color triangle

Theory of coloration

Color systems

Many color systems are proposed to describe human eye sensitivity at the basis of spectral measurements.

Problem: human eye has different sensitivity in other spectral areas …
Maximal sesitivity at 550 nm (green light)



Theory of coloration

<u>Color difference</u> (In textile branche – extreme important !!!)

<u>Comparison between STANDARD and SAMPLE should be exact !!!</u>

Basic easy question: Is the difference observable by human eyes?
Different answer: It depends on many imputes: light (illumination), distance, people…

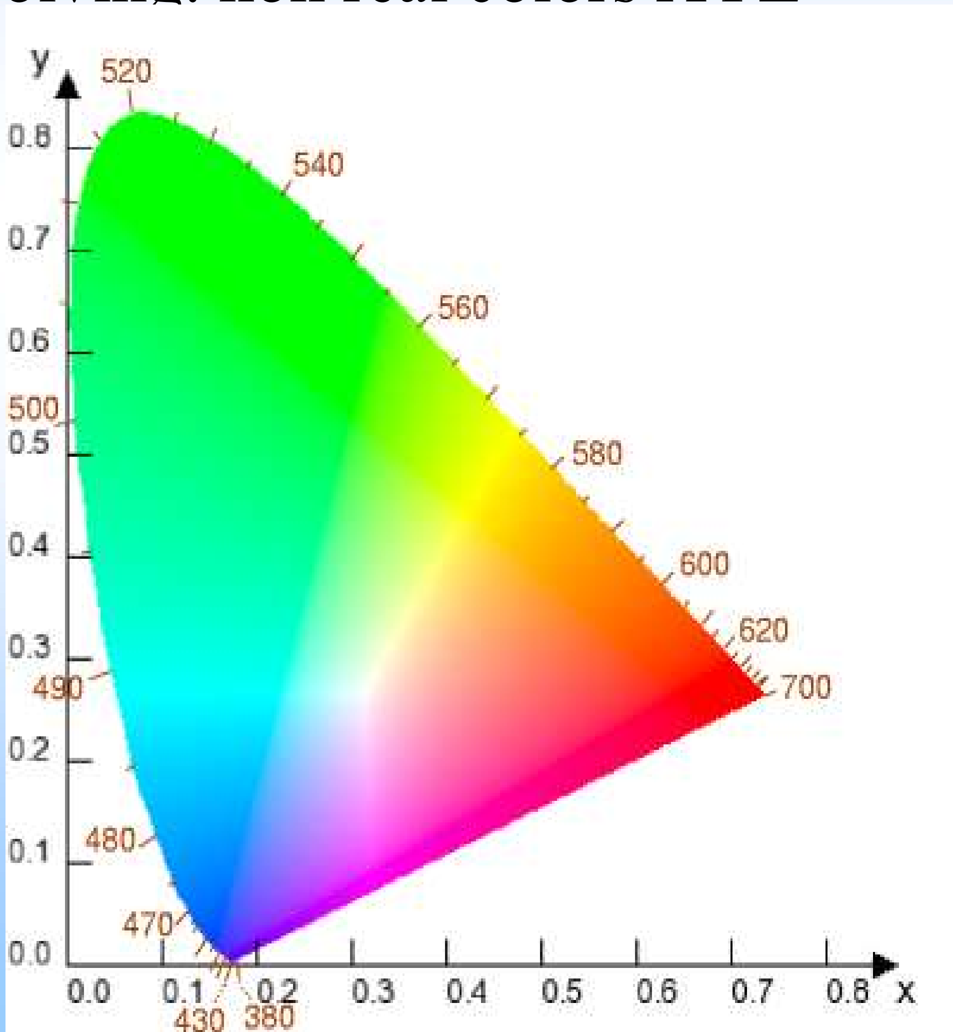
Color system idea: distance between two points (color) in color systems will be the same as a visual difference between the real colors
The problem of color difference will be only the geometrical problem…

Color measurement XYZ

RGB – same problems with real dyes

Solving: non real colors XYZ

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 2.7689 & 1.7518 & 1.1302 \\ 1.0000 & 4.5907 & 0.0601 \\ 0.0000 & 0.0565 & 5.5943 \end{bmatrix} . \begin{bmatrix} r \\ g \\ b \end{bmatrix}$$



$$x = \frac{X}{X + Y + Z}$$

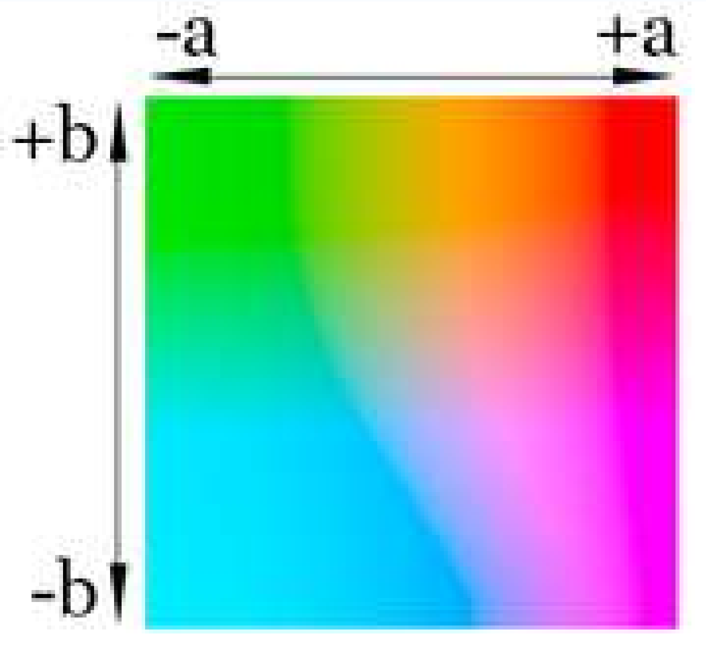
$$y = \frac{Y}{X + Y + Z} \qquad 1 = x + y + z$$

$$z = \frac{Z}{X + Y + Z}$$

Color measurement CIELab

Useful system: **CIELab**

Values **L***, **a*** a **b*, are calculated from X, X0, Y, Y0, Z** and **Z0** according equations



L* brightness

(higher L* = sample is more light).

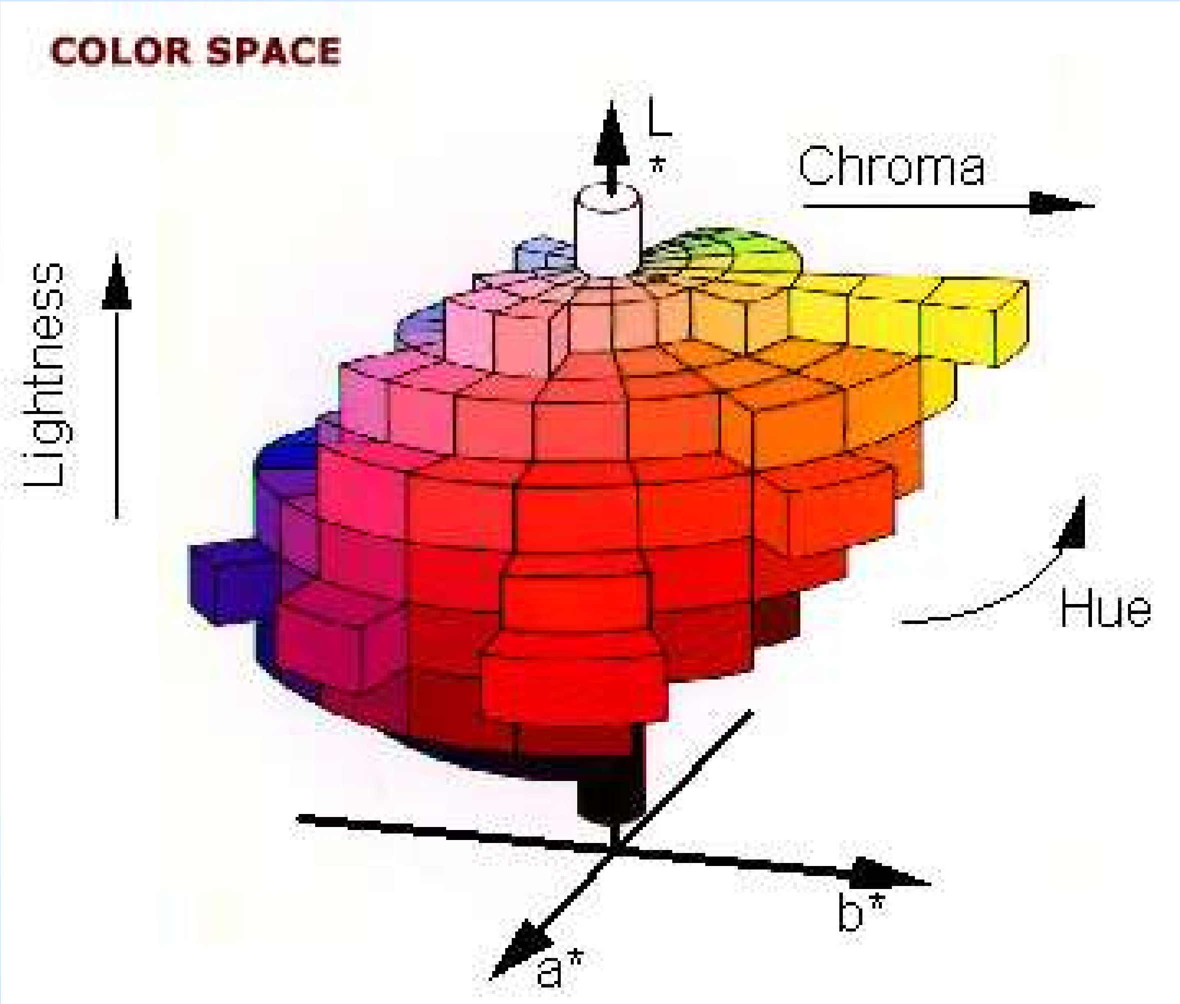
a* positive = sample is **red**

a* negative = sample is green

b* positive = sample is yellow

b* negative = sample is blue

Color measurement CIELab



Systems CIELab (CIELCH) are useful for comparison between standard and sample.

Color measurement CIELab

„Pass“ - „Fail“

IS the color of sample the same as a color of standard? Is it „pass“ or „fail“?

Criterion is „color difference“ ΔE. The color difference is zero, if is ΔE smaller then 1.

$$\Delta E = \sqrt{(L_1* - L_2*)^2 + (a_1* - a_2*)^2 + (b_1* - b_2*)^2}$$

„1“ matches to sample

„2“matches to standard

Carpets

Prints

Same colour different textures




Introduction to dyeing

Dyeing in Textile Production

Fiber production

Spinning

Weaving / Knitting

Finishing

Pretreatment

Dyeing

Printing

Final Finishing

CMT

End user

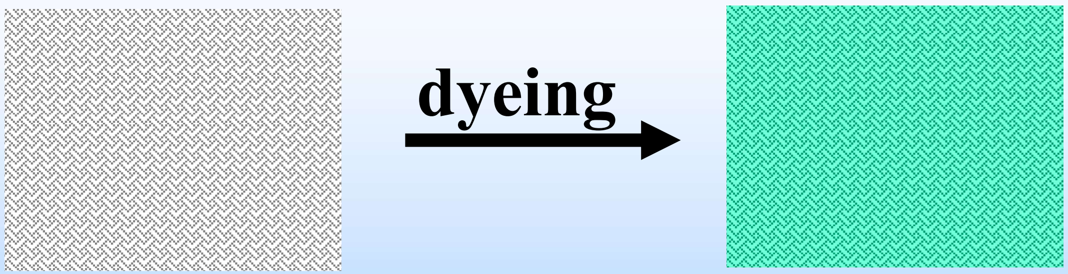
Life cycle end

Right dyeing

Right dyeing: <u>Accuracy of dyeing = Reproducibility</u>

Dyeing is spontaneous process – if you change the concentration of dye or chemicals, temperature $\pm$ 50 %

- always you obtain **some** color textiles

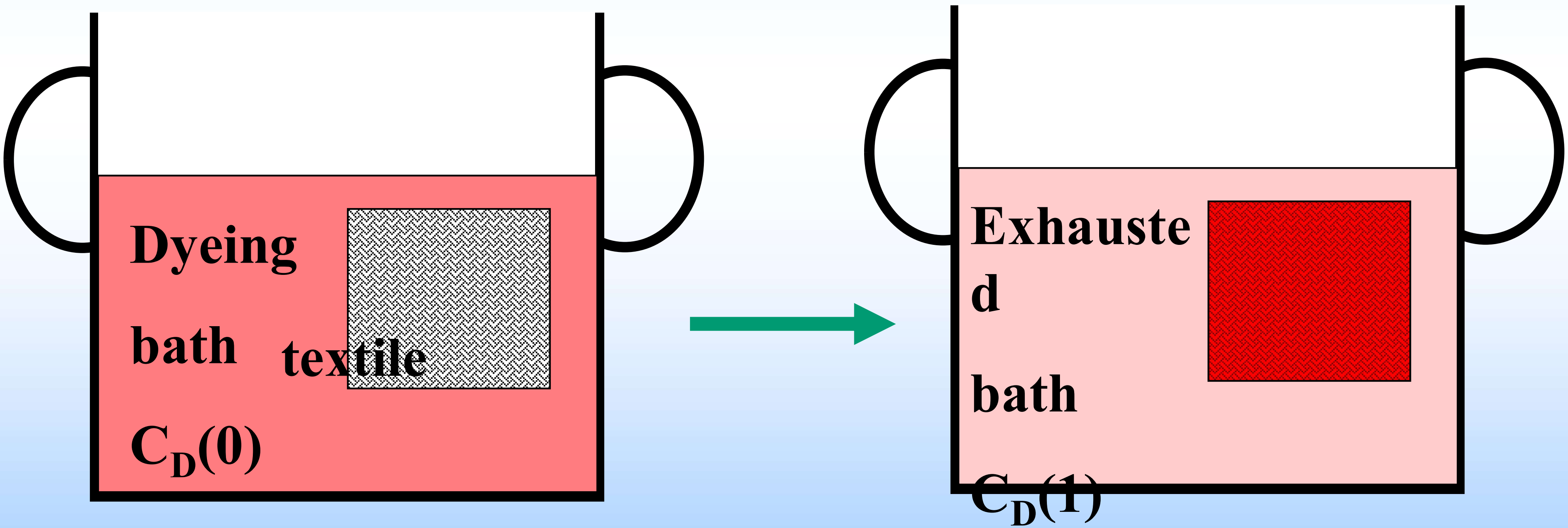


You must obtain <u>something more</u> – textiles with <u>defined</u> color, <u>perfect</u> color evenness, high <u>fastness</u>.

Exhaustion dyeing

Dyestuffs sorb to the fabric from the liquor

Description: discontinual, spontaneous process



Exhaustion:

$$\%E = \frac{C_D(0) - C_D(1)}{C_D(0)} .100\%$$

Basic terms – Liquor ratio

- Ratio between weight of fibers and the volume of liquor
- Sample: 1:50
- *Shorter liquor ratio = cheaper but not so even*

Liquor ratio	Volume of liquor for dyeing 1 kg of fibers
1:5	5 litre
1:10	10 litre
1:50	50 litre

Basic terms - Dye %

dye % of weight of fibers (% o.w.f.)

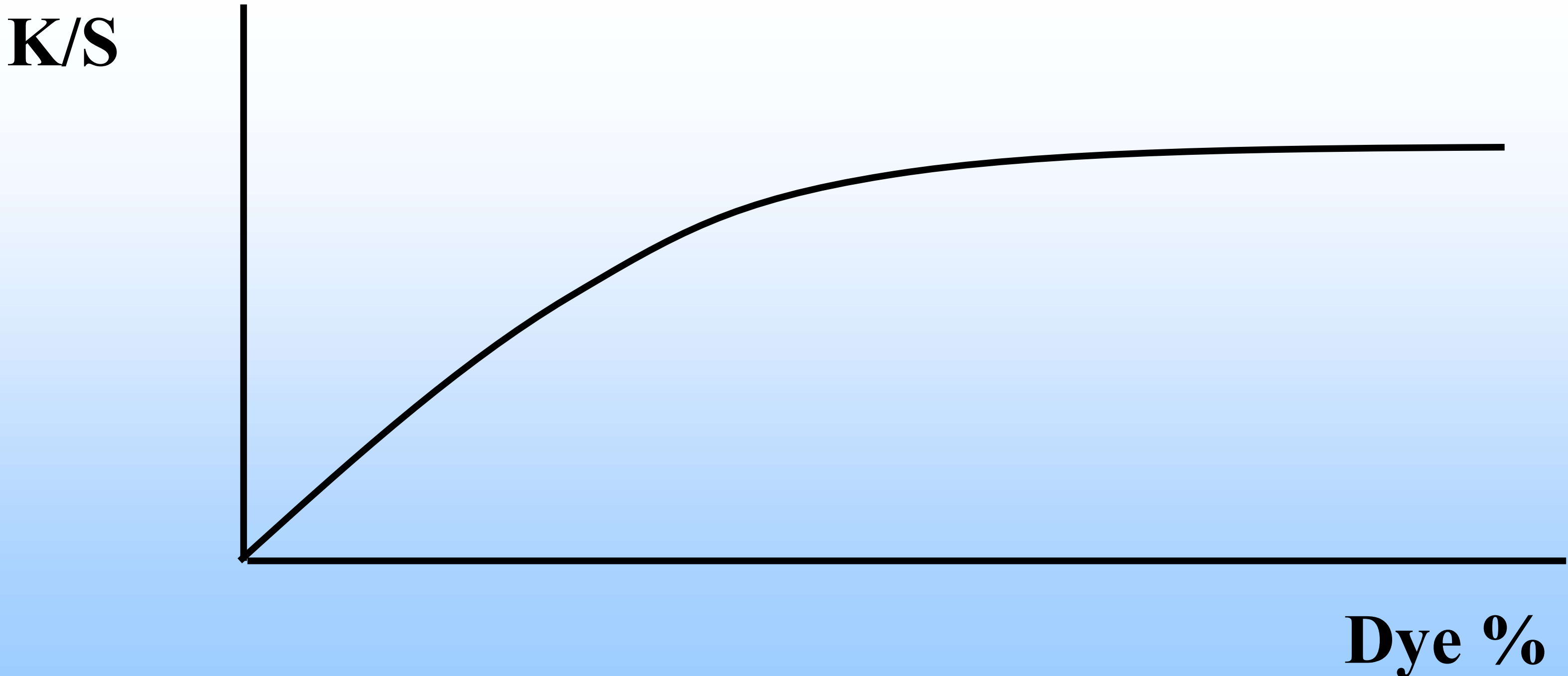
- Quantity of dye in dyeing bath
- % of weight of fibers

- Light shades 0.3-0.5%
- Middle shades 1-1.5%
- Dark shades about 3%

Dye %	Weight of dye for dyeing of 1 kg (1000g) of fibers
0.5%	5g
1 %	10 g
2%	20 g

Dye %

Influence of dye dosage



Sample of calculation I

Dyeing

Fibers: 8kg PL fabric
3 dyes: A (1%), B(3%), C (0.2%)
Liquor ratio 1:8

Total volume: **8 . 8 = 64 l**

Weight of dye A: **8 . 0.01 = 0.08 kg = 80g**
Weight of dye B: **8 . 0.03 = 0.24 kg = 240g**
Weight of dye C: **8 . 0.002 = 0,016 kg = 16g**

Sample of calculation I

Total volume: 8 . 8 = 64 l
Weight *of dye A: 80g*
Weight *of dye B: 240g*
Weight *of dye C: 16g*

Concentration of dyes in g/l in dyebath = ?

$C_A = 80/64 = 1.25$ g/l

$C_B = 240/64 = 3.75$ g/l

$C_C = 16/64 = 0.25$ g/l

Sample of calculation II

Prepare dyebath according this recipe:
15g sample, 1:20, 3% dye, 5 g/l Na_2CO_3

Total volume of dyebath: 15 x 20 = 300 ml = 0,3 l
weight of dye: 15 x 0.03 = 0.45 g
weight of Na_2CO_3: 0.3 x 5 = 1.5 g

solution of Dye : 10 g/l

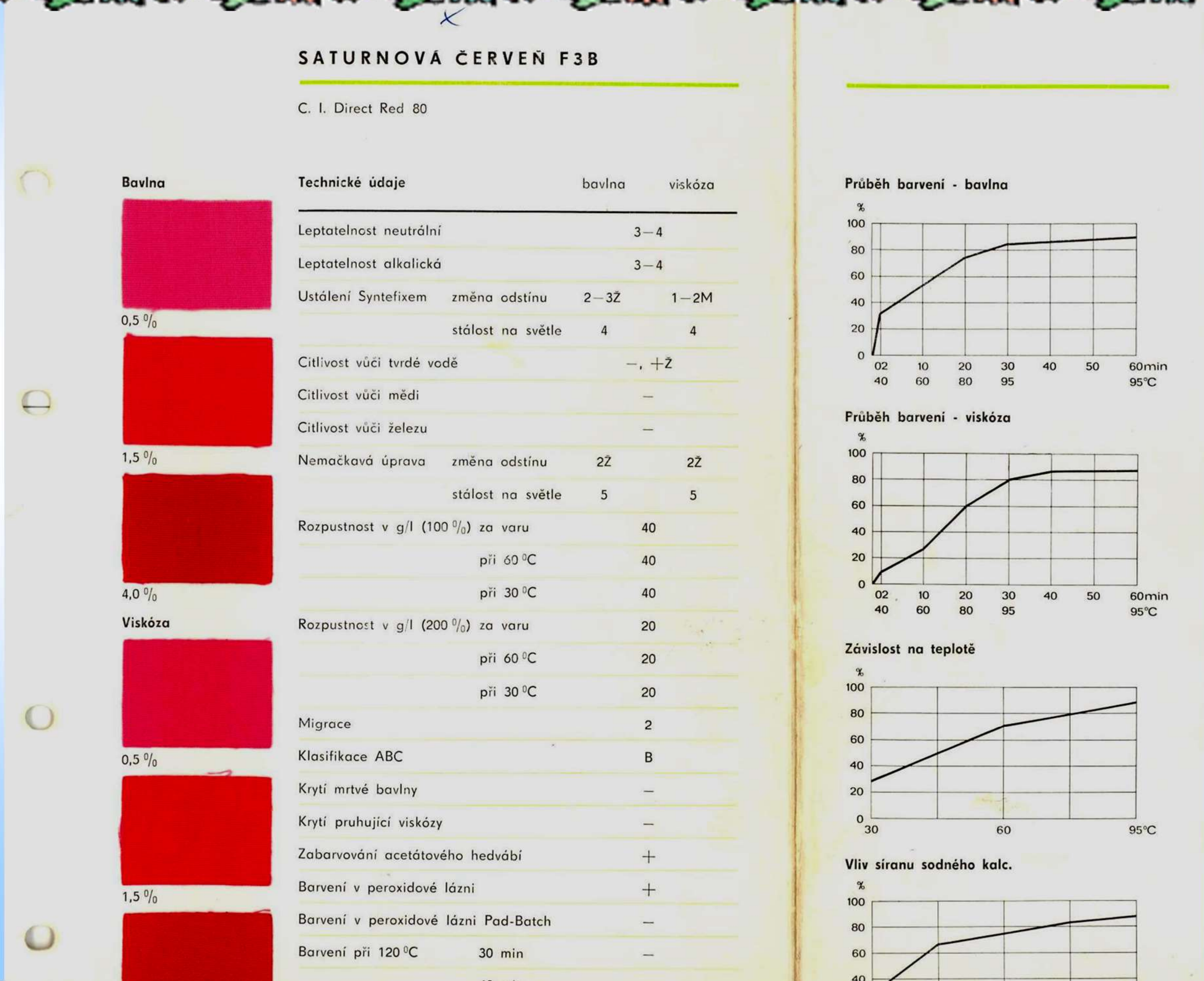
solution of Na_2CO_3 : 50g/l

volume of dye solution: 0.45/10 = 0.045 l = 45ml
volume of Na_2CO_3 solution: 1.5/50 = 0.03 l = 30 ml

Pattern cards

enough for practice

- basic shades (color, orientation)
- color index number (chemical structure)
- fastness (to water, light, washing …)
- application methods
- solubility
- compatibility


SATURNOVÁ ČERVEŇ F3B

C. I. Direct Red 80

Bavlna: 0,5 %, 1,5 %, 4,0 %

Viskóza: 0,5 %, 1,5 %

Technické údaje		bavlna	viskóza
Leptatelnost neutrální		3–4	
Leptatelnost alkalická		3–4	
Ustálení Syntefixem	změna odstínu	2–3Ž	1–2M
	stálost na světle	4	4
Citlivost vůči tvrdé vodě		–, +Ž	
Citlivost vůči mědi		–	
Citlivost vůči železu		–	
Nemačkavá úprava	změna odstínu	2Ž	2Ž
	stálost na světle	5	5
Rozpustnost v g/l (100 %) za varu		40	
	při 60 °C	40	
	při 30 °C	40	
Rozpustnost v g/l (200 %) za varu		20	
	při 60 °C	20	
	při 30 °C	20	
Migrace		2	
Klasifikace ABC		B	
Krytí mrtvé bavlny		–	
Krytí pruhující viskózy		–	
Zabarvování acetátového hedvábí		+	
Barvení v peroxidové lázni		+	
Barvení v peroxidové lázni Pad-Batch		–	
Barvení při 120 °C	30 min	–	

Pattern cards

SATURNOVÁ ČERVEŇ F3B

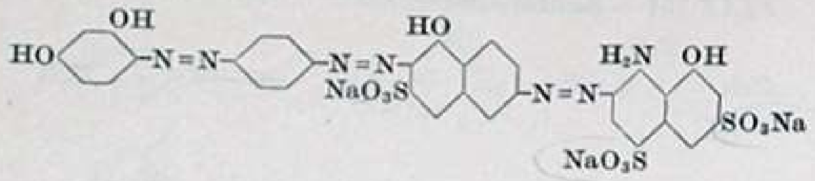
Stálosti

	bavlna					viskóza				
síla pomocného typu	1/12	1/6	1/3	1/1	2/1	1/12	1/6	1/3	1/1	2/1
Denní světlo	2—3	3—4	4—5	5	5	3	3—4	4	5	5—6
Světlo Xenotest	3	3—4	4—5	5	5	3	3—4	4	4—5	5—6

síla pomocného typu	bavlna 1/1						viskóza 1/1					
	ustáleno			neustáleno			ustáleno			neustáleno		
Voda	**4M**	**4**	**5**	4M	2	4	**4—5**	**4—5**	**5**	4	3	4
Praní 40 °C	**4**	**3—4**	**4—5**	3	3	4—5	**4**	**4—5**	**5**	4	4	4—5
Praní 60 °C	**3-4M**	**2**	**4—5**	2—3	1—2	4—5	**4**	**3—4**	**4—5**	3	2	4—5
Pot kyselý	**3-4M**	**4—5**	**5**	3ŽJ	2—3	4—5	**4**	**5**	**5**	3ŽJ	4	5
Pot alkalický	**3-4MK**	**4—5**	**4—5**	4ŽJ	2—3	4—5	**4**	**4—5**	**5**	3ŽJ	4	5
Valcha alkalická, mírná zkouška	**4**	**3**	**5**	3—4	2	4—5	**4**	**4—5**	**5**	3-4Ž	4	4—5
Mořská voda	**4**	**4—5**	**5**	3-4Ž	3—4	4—5	**4**	**4—5**	**5**	3-4Ž	4	5
Žehlení za sucha, ihned				3-4M						4Ž		
Žehlení za sucha, po 4 hodinách				4M	5					4Ž	5	
Žehlení za vlhka, ihned				3-4M						4M		
Žehlení za vlhka, po 4 hodinách				4MK	5					4M	5	
Dekatura, lehká zkouška				4ŽK						3Ž		
Fixace a plisování suchým teplem				4Ž	4—5	5				4Ž	4—5	5
Vulkanizace za studena				4—5						4—5		
Vulkanizace horkým vzduchem				4K						4—5		
Vulkanizace párou				2-3M	1—2					3M	2	
Alkálie				2-3M						2-3M		

Color index

31620★ Direct Dye

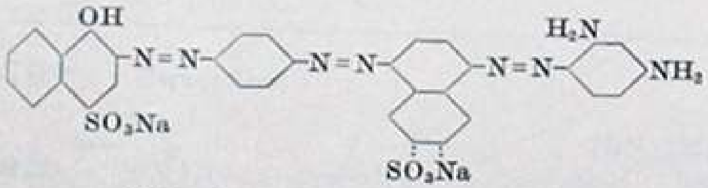


p-Aminoacetanilide ↗ (3) *hydrolyse amide group* → (4) Resorcinol
↘ (1) (*alk.*) J acid → (2) (*acid*) K acid

Discoverers — A. Blank and K. Heusner 1909
Para Black GG (By)
Fastness Properties, coupled with diazotised *p*-nitroaniline: Acid (organic), Ammonia, Light and Washing, good
Dischargeability, good
Bayer Co., *BP* 9620/10; *USP* 969450; *FP* 424405; *GP* 24962
(*Fr.* **10**, 888)

Moderately soluble in water (dark violet)
Slightly soluble in ethanol
H_2SO_4 conc. — greenish blue; on dilution — dull violet
Aqueous solution + HCl conc. — violet black, ppt;
+ NaOH conc. — dark blue

31625★ Direct Dye

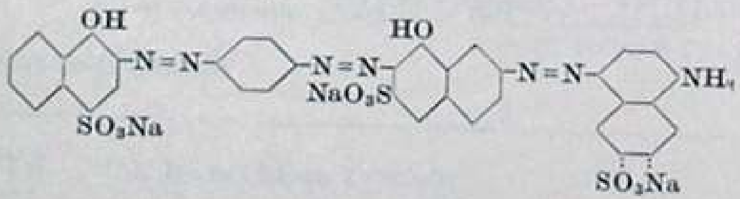


p-Aminoacetanilide ↗ (1) Nevile and Winther's acid
↘ (2) *hydrolyse amide group* → (3) 1,6(and 1,7)-Cleve's acid
→ (4) *m*-Phenylenediamine

Discoverer — Badische Co.
Oxamine Dark Blue R (B)
Fastness Properties (C): Acid (organic) 3, Alkali 5, Light 2, Washing and Water 1-2
FIAT 764 — Oxamindunkelblau R

Soluble in water (violet to black)
Slightly soluble in ethanol
H_2SO_4 conc. — bluish green; on dilution — corinth
Aqueous solution + HCl conc. — corinth ppt;
+ NaOH conc. — dark navy blue

31630★ Direct Dye



p-Aminoacetanilide ↗ (2) *hydrolyse amide group*] ↗ (4) Nevile and Winther's acid
↘ (1) (*alk.*) Gamma acid] ↘ (3) 1,6(and 1,7)-Cleve's acid

Discoverer — Kalle Co. 1901
Naphthamine Blue GE (K) may be developed with 2-naphthol

Soluble in water (dark blue)
Insoluble in ethanol
H_2SO_4 conc. — dark blue; on dilution — dullish violet
Aqueous solution + HCl conc. — navy blue ppt;
+ NaOH conc. — dark navy blue

31635 C.I. Direct Blue 33 (Reddish ...)

Color index

C.I. 17025 Monoazo **C.I. Acid Violet 1**

APPLICATION

DYEING

Wool Good exhaustion from a sulphuric acid and Glauber's salt dyebath

Levelling: S.D.C. Migration Test {Dyeing method I, Migration 3}

Nylon Dyed from an acetic or formic acid dyebath

Unions Wool and nylon dyed, silk stained, cellulose and acetate unstained

Method	
Neutral	☐
Weak Acid	◘
Sulphuric Acid ...	■
Chrome in Dyebath	◘

PRINTING

Wool and Nylon For direct print styles

FASTNESS PROPERTIES etc

		A	B	C
Alkali		3	...	4
Carbonising		4	4–5	4–5
Chlorination Alteration		...	2	
Chlorination Staining	Wool	...	5	3
	Cotton	...	5	
Decatising		4–5	2	4–5
Light ½–¼ Normal		2	4	4
Normal		3	4–5	4–5
2 × Normal		4	5	5
Milling Alkaline Alteration			1	2
Staining	Wool	1	2	2
	Cotton		2	1–2
Milling Acid Alteration		...	3	
Staining	Wool	...	2	3
	Cotton	...	4–5	

		A	B	C
Peroxide Bleaching Alteration			1	
Staining	Wool	2	5	2–3
	Cotton		3–4	
Perspiration Alteration		3	3–4	
Staining	Wool	1	2	2–3
	Cotton		2	
Potting Alteration		...	1	
Staining	Wool	...	1	1
	Cotton	...	5	
Sea Water Alteration			1	
Staining	Wool	2	1	3
	Cotton		1	
Stoving Alteration			1	
Staining	Wool	1	5	1–2
	Cotton		4	
Washing Alteration			1	1
Staining	Wool	1	4	3–4
	Cotton		3	2–3

Dischargeability Good

Solubility Water, very good

Effect of Metals Copper, duller: Iron, duller

TEXTILE USAGE

Chiefly as a combination dye on piece goods as a base for navy blues. Suitable for yarns and felts

Suitable for nylon, the fastness properties being (A): Light 2, Milling (alkaline) 3, Perspiration, alteration 5, staining 2, Washing 4–5

PRINTING

Of limited interest on wool and nylon

Hue **Dull Reddish Violet**

Artificial Light: redder

Acid Fast Violet RL	Fran
Acilan Fast Violet RR	FBy
Amacid Fast Victoria Violet R ...	AAP
Azo Fast Violet 2R	CFM
Calcocid Fast Violet 2R	CCC
Cetil Light Violet RR	Ipca
Erio Violet RL	Gy
Fast Acid Violet RL	RBM
Fast Acid Violet VR	FDN
Fast Azo Violet RL, 2RS	YDC
Fast Light Violet 2R	Acna
Fast Wool Violet 2R	NAC
Fenazo Violet T	G
Java Fast Violet 2R	Vond
Kiton Violet L	CAC
Kiton Violet L	Ciba
Lissamine Violet 2R	ICI
Merantine Violet 2RS	LBH
Pontacyl Violet RL	DuP
Tertracid Violet RL	CT
Victoria Fast Violet RRN-CF	G
Victoria Fast Violet 2R	FNC
Xylene Violet RL, RLE	S

NON-TEXTILE USAGE

Leather On chrome tannage, and occasionally used for finish colouring

Paper Of limited interest

Levelness

Evenness (levelness) – color undepends on position

Different forms:

- Standard: low difference (at the human eye sensitivity)

Reasons:

- **Fibers** – difference in sorption properties, fineness, ...
- **Dyeing** – temperature, dye mixing...

Low evenness is sometimes positive: Batik →

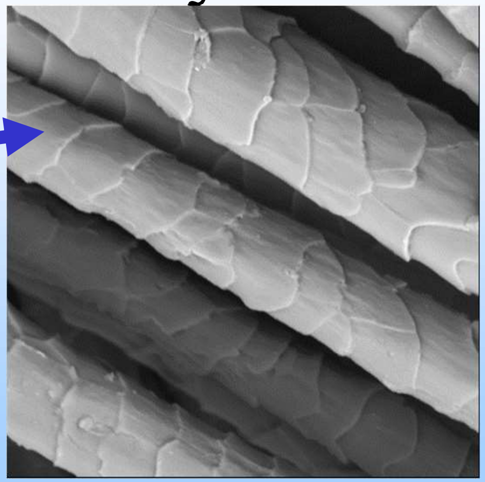
Levelness on wool fibers

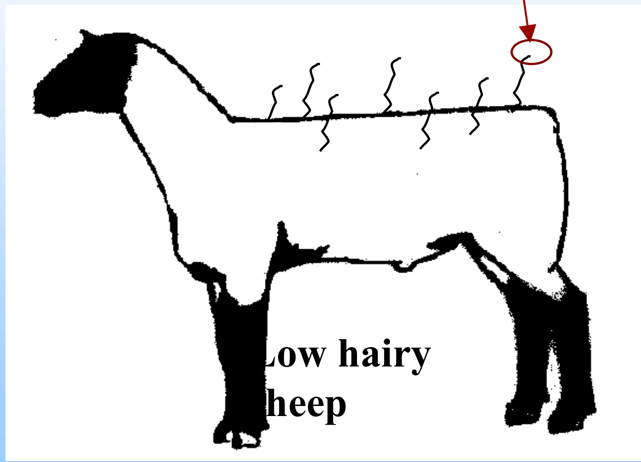
<u>Wool -</u> TIPPINESS.

Natural fiber from proteins, origin: Sheep

The wool grows on the sheep for a long time. The ends of fibers are influenced by sun, air, water and mechanical rubbing. The surface is changed.

Original hydrophobic surface is at the fiber end hydrophilized – hydrophilic dyes sorb quickly into fibers.

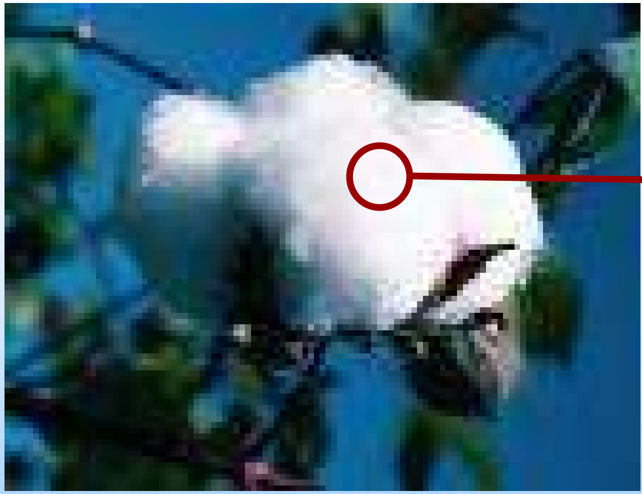


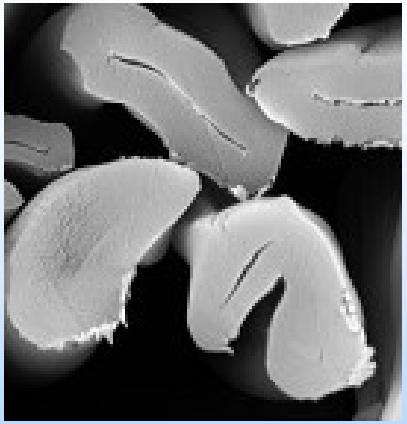


Levelness on cotton fibers

Cotton

Cotton is pretreated in many steps and many problems of dyeing are connected with worse pretreatment. For example damage of fibers by acids, uneven boiling...





Levelness

Cotton

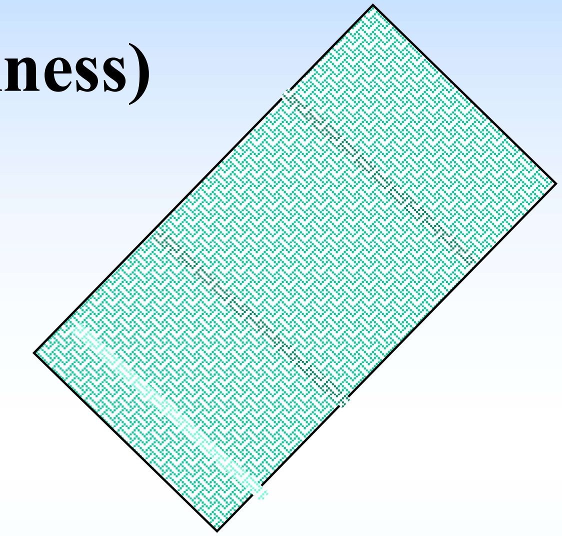
In cotton are mixed fiber with different maturity (immature, dead, overmature cotton).
The dyeability is different (other dye affinity, rate of dyeing, light scattering properties).

Low quality cotton with different maturity degrees is possible identify by microscopy or by dyeing tests (Red-green test)

extremely immature fibers create a reflective surface

Levelness on synthetic fibers

Special kind of unlevelness is barriness (stripiness)



Possible reasons:
<u>Problems start before weaving !!!</u>

1) **Different degree of polymerization of fiber formic polymer – different quantity of end groups (typical by PA fibers) – problem of fiber producer**

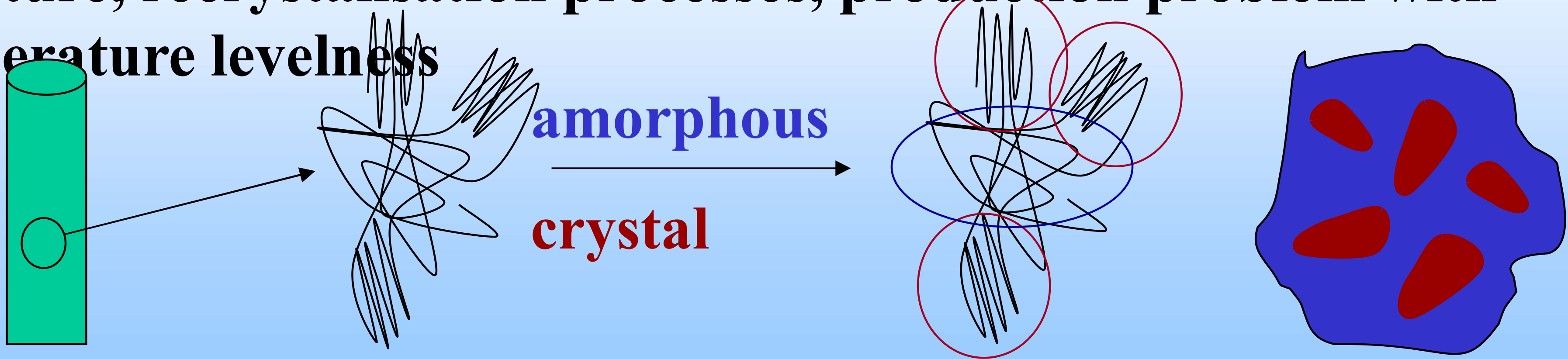
2) **Differences in fiber cross section (diameter, shape...) and unlevelness of delustrant in fibers – connected with the property and purity of fiber forming jets, these changes occur differences in optical properties of fibers**

Levelness on synthetic fibers

3) Differences in macromolecular structure - orientation, crystalinity

Dye can be sorbed only to amorphous part of fibers (crystals are to much oriented and stable) – problem of fiber producer from spinning

Fiber setting (about: 200°C, 30 s) – changes of macromolecular structure, recrystalisation processes, production problem with temperature levelness



Improving of color levelness

1) <u>Problem is based on fiber quality</u>

Only prevention – good (even, enough intensive) pretreatment, good organization of production (never mix fibers with different dyeing properties)

2) Problem is based on dyes

Prevention: using of recommended dyes combinations, long migration phases in dyeing

Using of leveling agent (LA) – chemical included to dying system to reduce rate of dyeing and affinity of dye to the fibers

Improving of color levelness

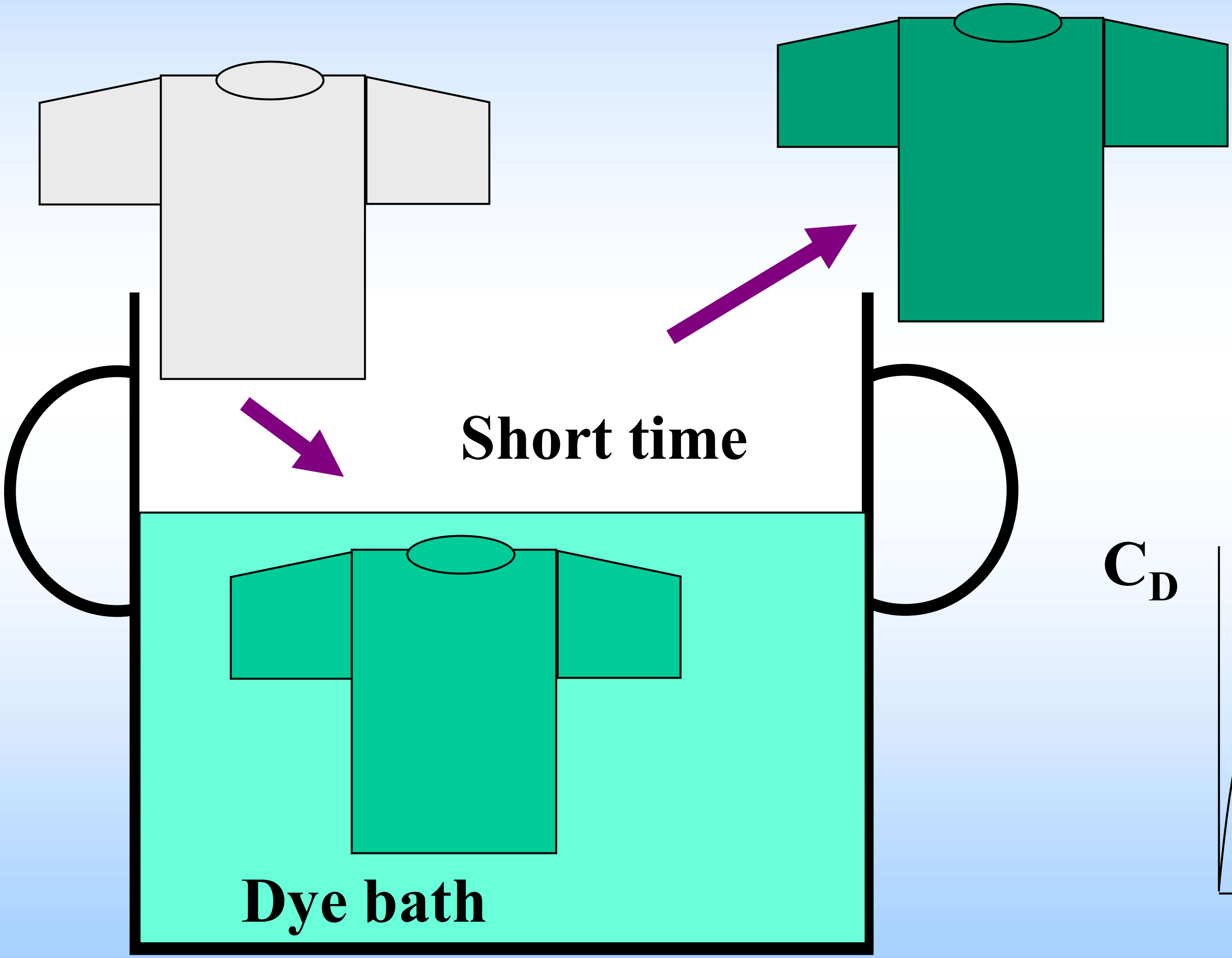
Possible leveling agent (LA) according the effect and ionogenity:

Dye affine LA*– *effect is based on complex c between dye and LA, the concentration of free dye („prepared for sorption“) induced, if the free dye is exhausted from the liquor, than is new free dye produced, for anionic dyes are used cationic LA

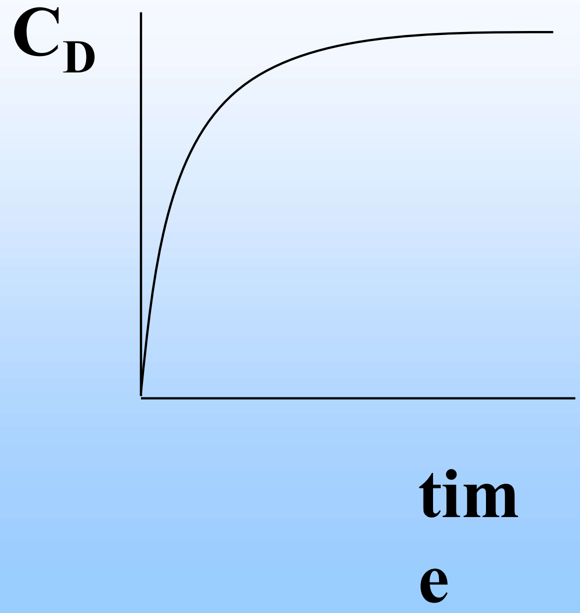
Similar effects have solubilization agents, which increase the solubility of dye (urea, alkali, surfactants...)

Fiber affine LA – these LA are concurrent to dyes, in the dyeing system is LA with small molecules (low affinity and high rate of sorption), LA sorbed in fibers first, and the dyestuff replaced LA during the dyeing process

Rate of dyeing

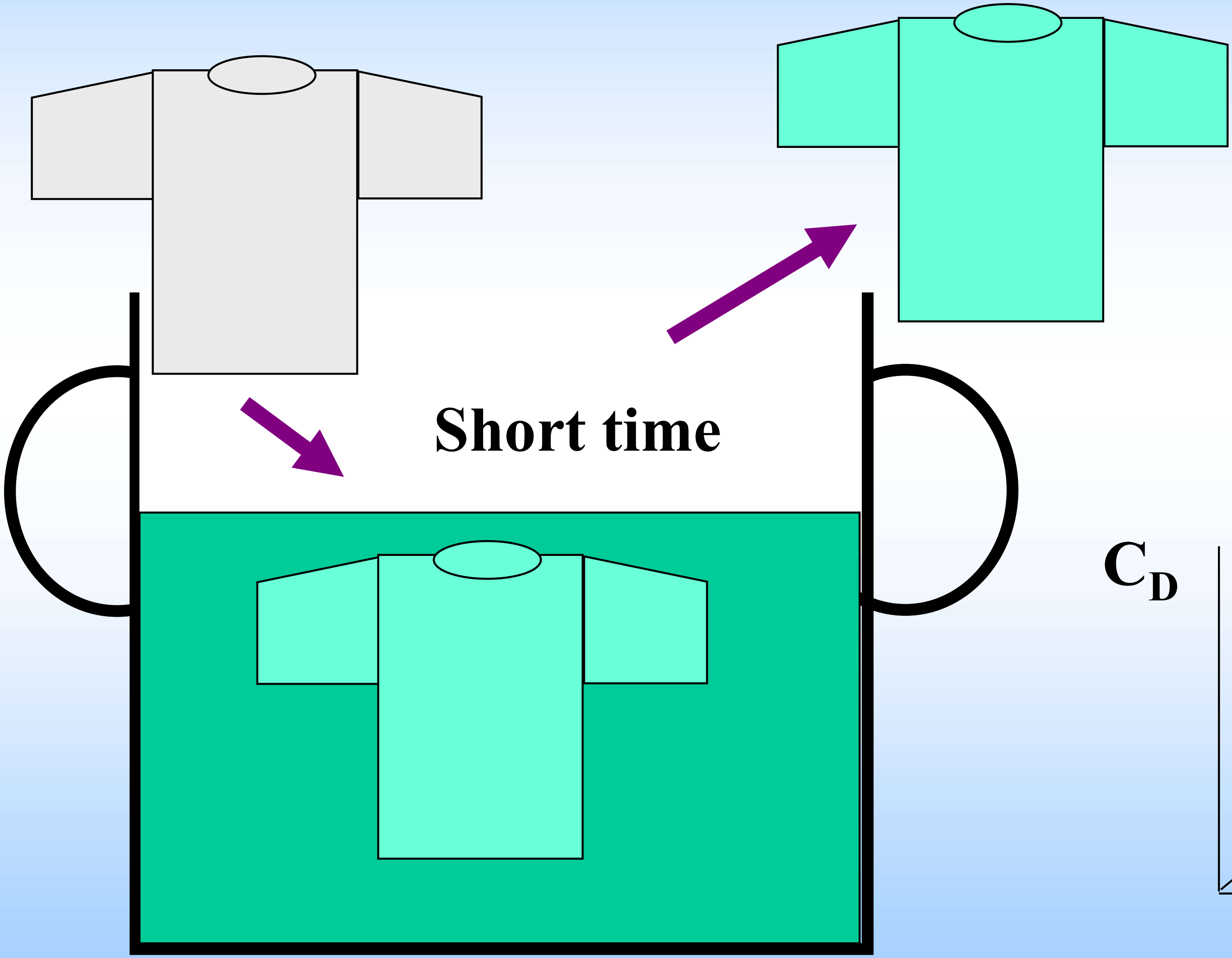


Quickly process

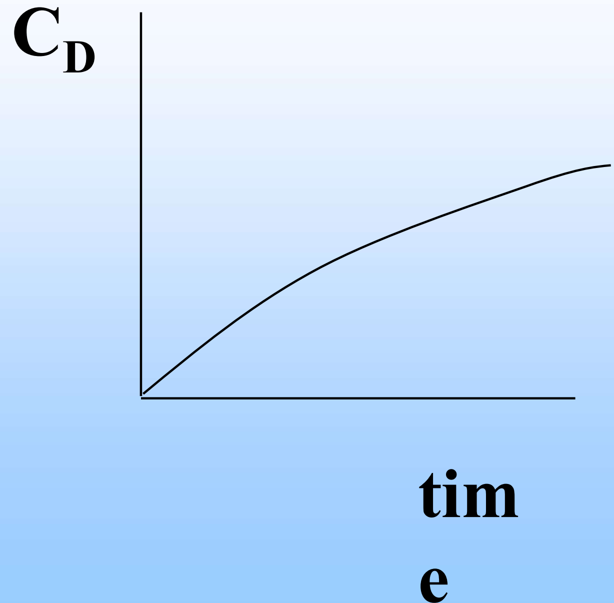


Possible problems with levelness

Rate of dyeing



Slowly process

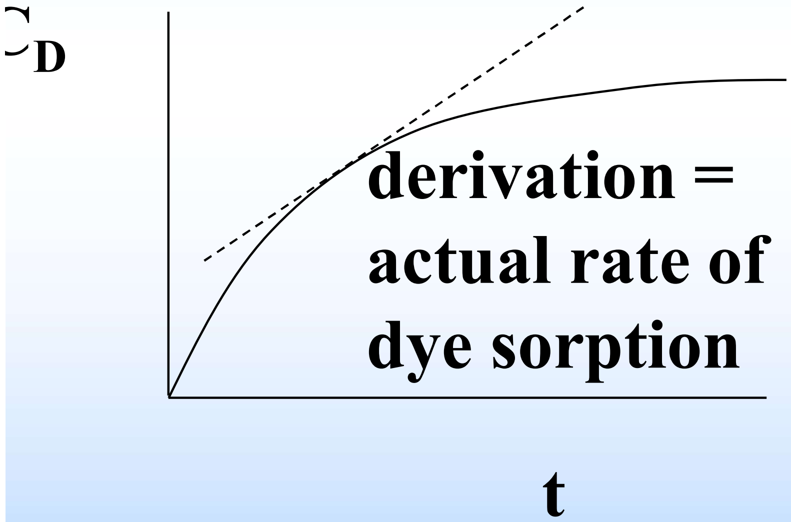


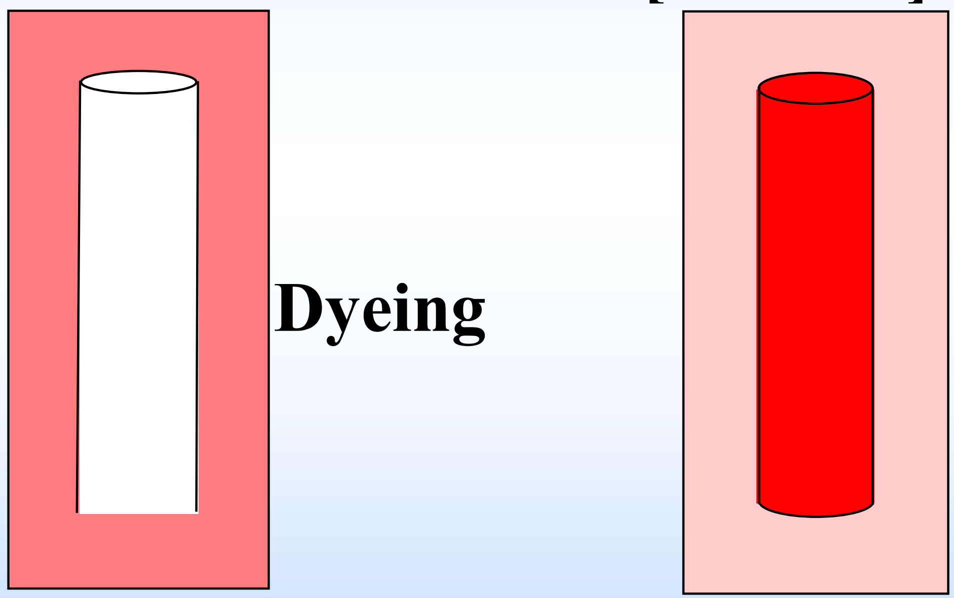
Long time of dyeing

Rate of dyeing

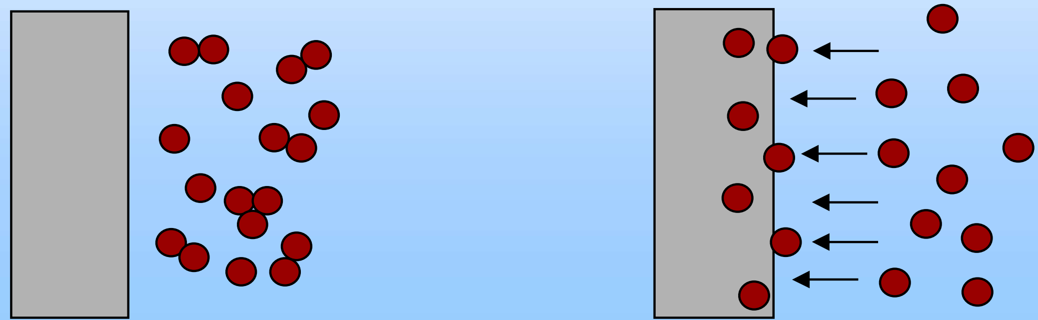
Rate of dyeing = haw quickly we are getting near of process equilibrium

Typical description C_D [mg/g] as a function of time [minutes]

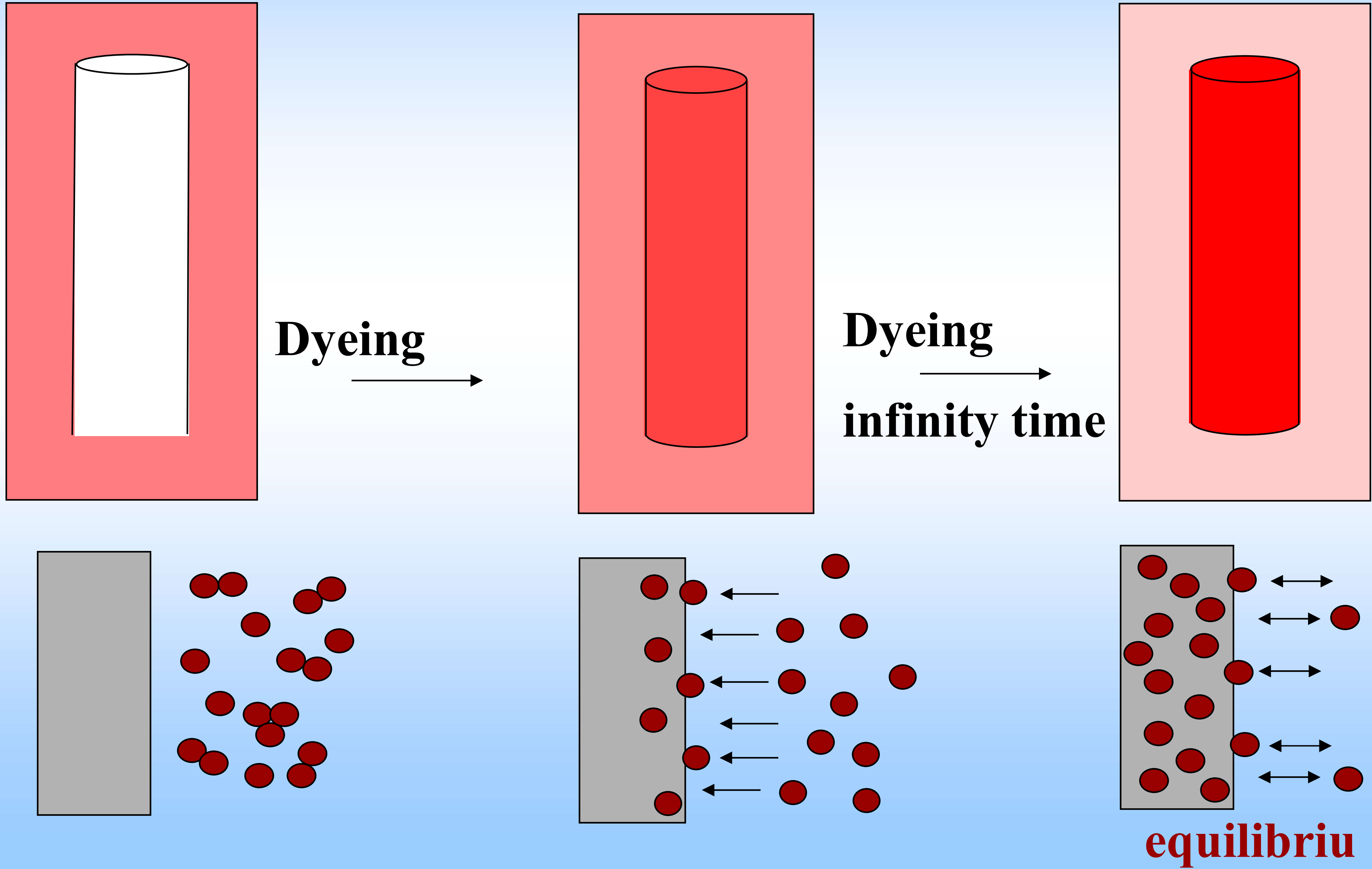




Other possibilities: half time of dyeing, rate constant from kinetic models ...

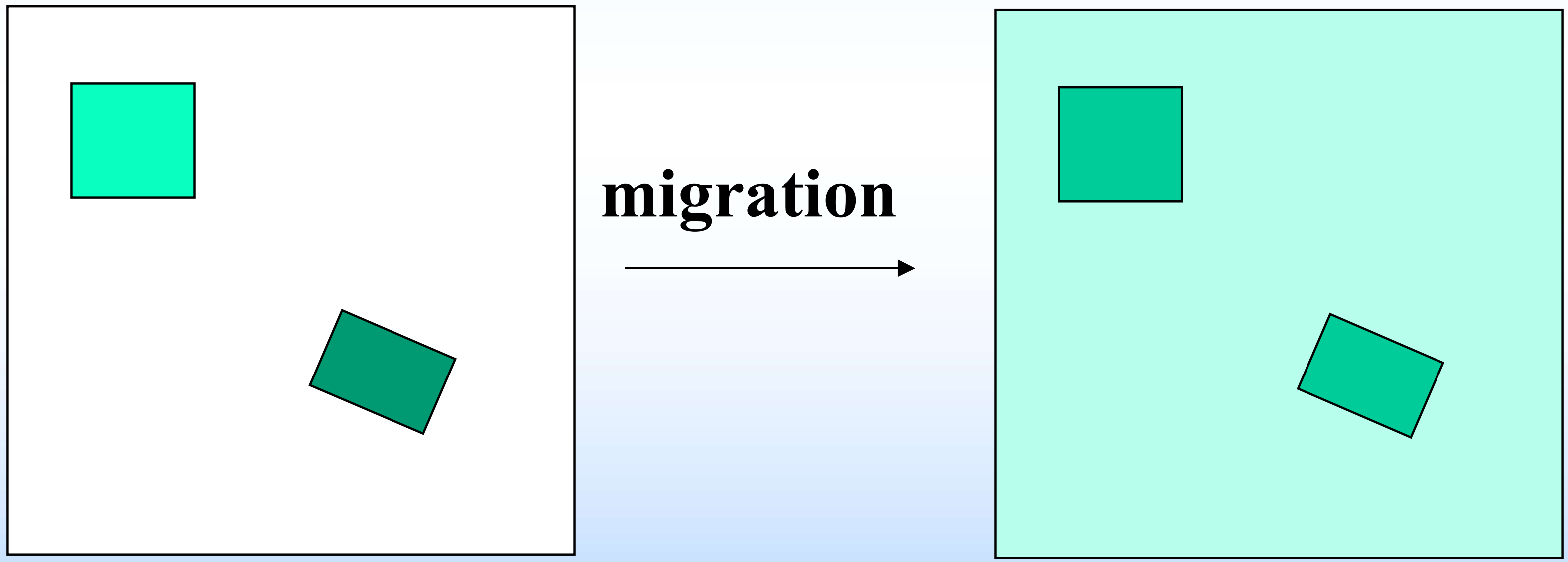


Dyeing equilibrium



Migration

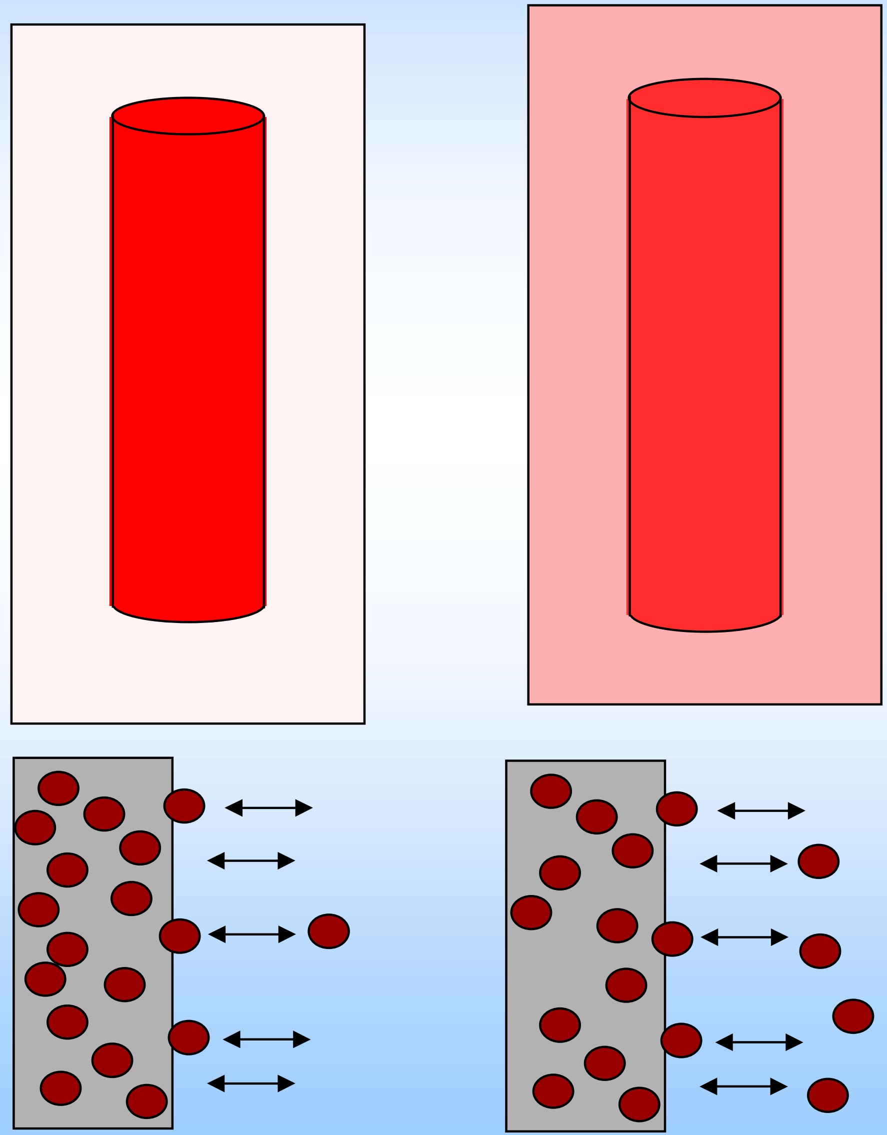
Migration – transport of dyestuff trough the solution from places with high concentration to the low concentration



Migration

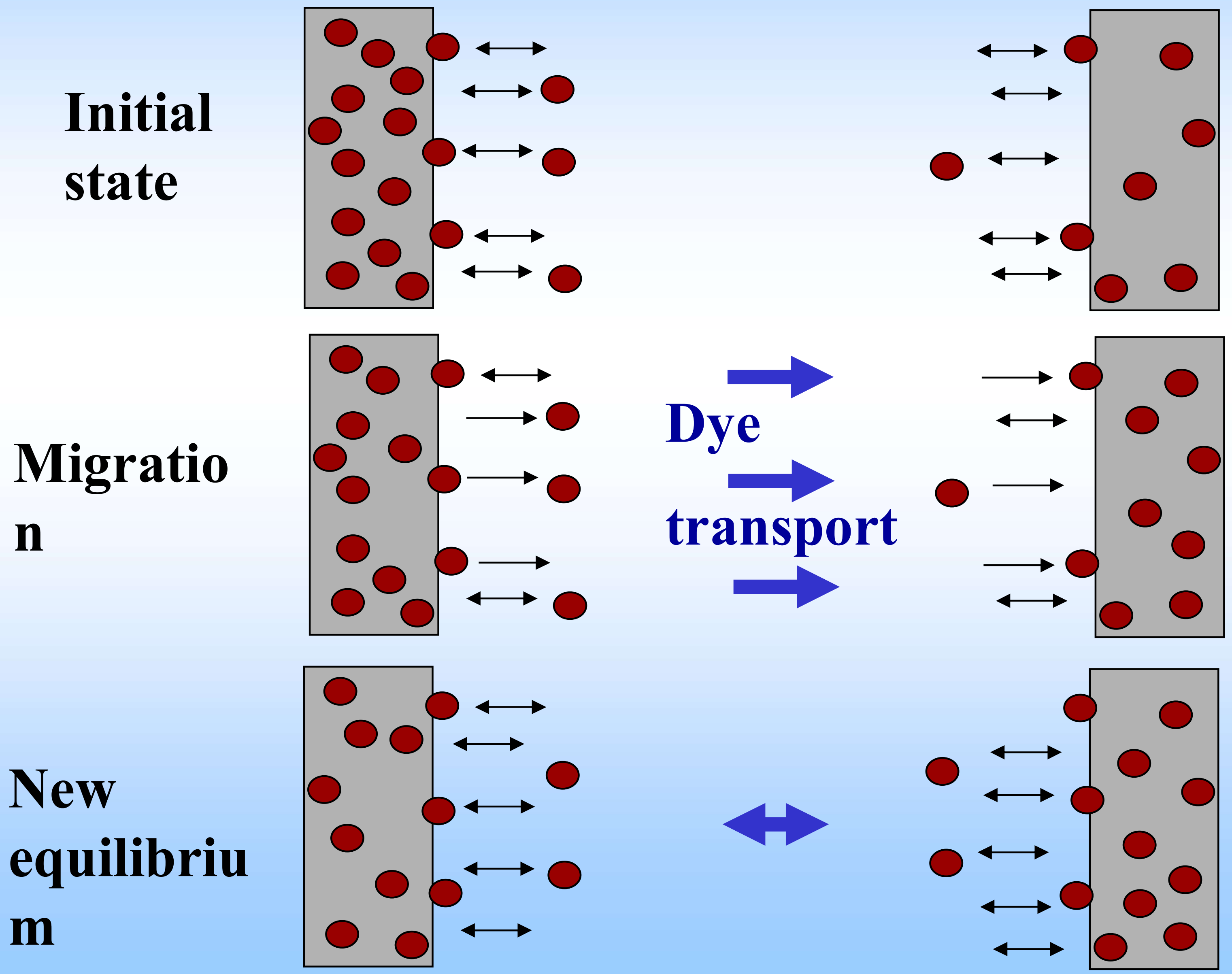
Migration is a positive process – increase the levelness of color

Higher migration: dyes with low affinity and high rate of dyeing

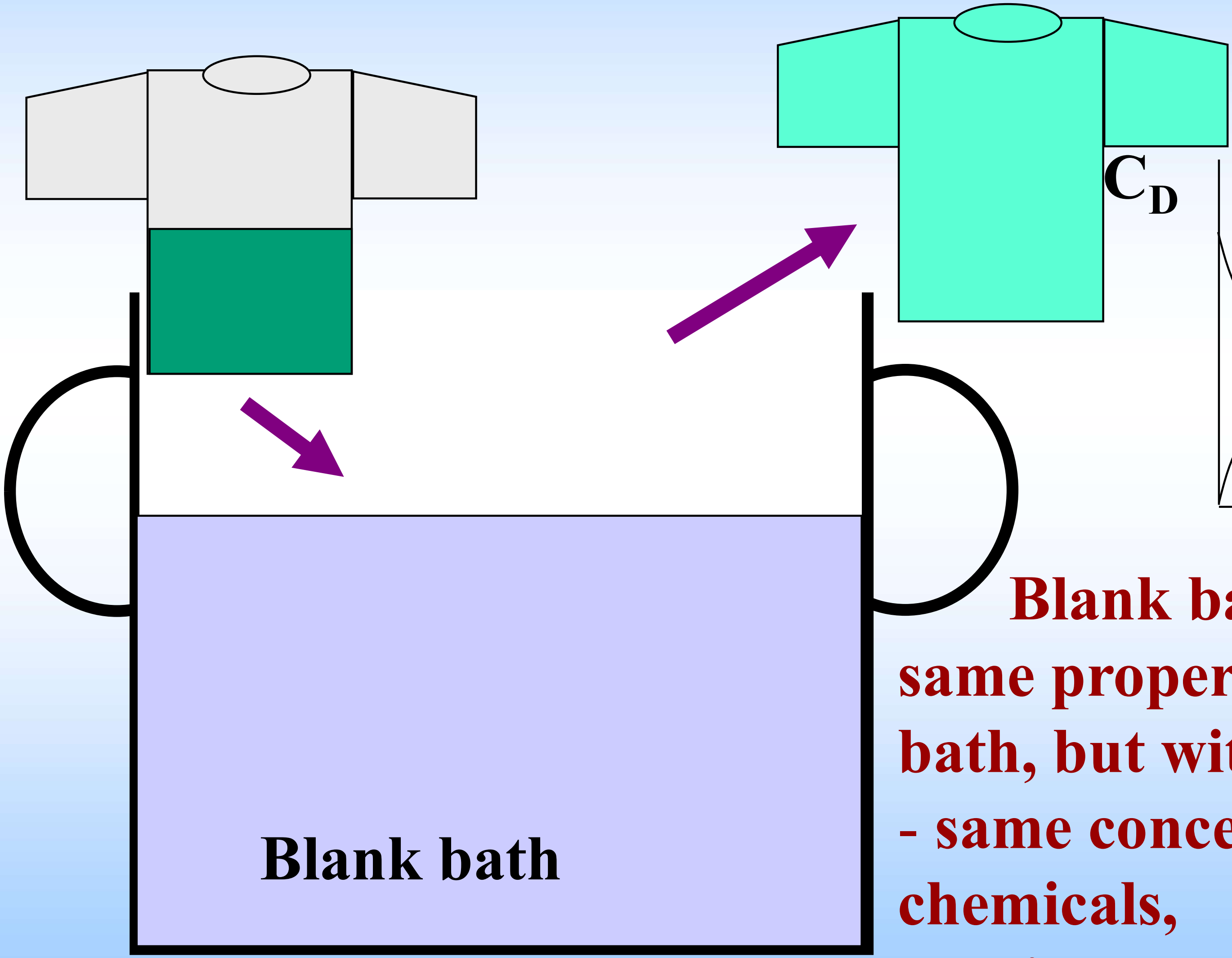


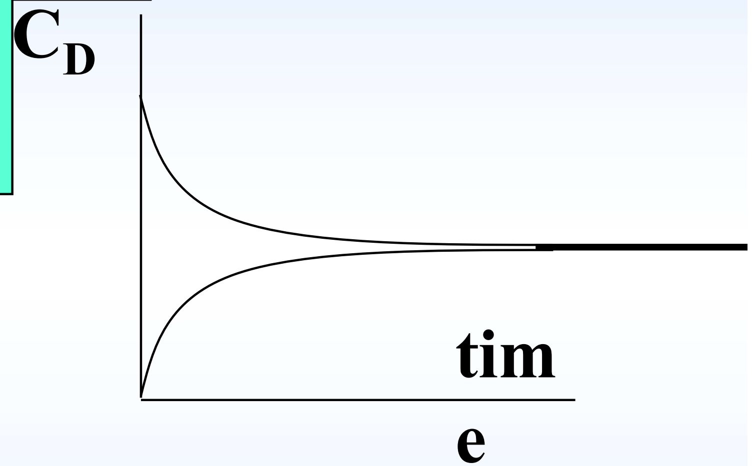
high affinity **low affinity**

Migration



Migration (good=intensive)





Blank bath – bath with same properties as a dyeing bath, but without dye !!!

- same concentration of chemicals,

- typically same liquor ratio, temperature...

Migration (bad=low)