

# NEW WATER BASE LIQUID PENETRANT. WHAT CHANGES.

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## **SUMMARY**

The liquid penetrant are since 50 years the simpler and less expensive method to find defects. During this period they have endured numerous evolutions in their formulations in order to answer to new requirements.

Recently new liquid penetrant have been introduced, red or fluorescent, called W.B. Water Base, where their main component (70-80%) is the water rather than the petroleum solvents like in the traditional penetrant or the surfactants as in “the BIO ” penetrant.

The advantages inborn in the new formulation deriving from the possibility to apply to new procedures have been analyzed.

## **PREMISED**

A traditional water washable liquid penetrant, red or fluorescent, is essentially composed by: dyestuffs, surfactants (they make it emulsifiable in water) and 70/80 % of petroleum solvent.

A BIO penetrating liquid does not contain petroleum solvents, but mixtures of biodegradable surfactants and dyestuffs.

A Water Base liquid penetrant (later on abbreviated W.B.), uses water as diluting product in place of petroleum solvent.

The advantages to use water as diluting, an economic element, not polluting, easy available, in place of the petroleum solvent, are obvious, so that today the w.b. varnishes, the w.b. detergents, etc have replaced the products made up by petroleum solvents.

## **ADVANTAGES**

The advantages of W.B. penetrant are multiple, some in the use of the water in place of the petroleum solvent or the surfactants, other related to the fact that the liquid penetrant must be used in sequence with other chemical products that complete the control procedure and include:

- 1. LOWER COST PER LITER:** the cost of the petroleum solvent (assimilable to the cost of fuels) or the biodegradable surfactants (much more expensive) for more than half a liter for every liter of penetrant, is saved.

2. **LOWER WATER TREATMENT COST:** the water contained in the penetrant has no polluting burden while the emulsified petroleum solvent in the washing water must be deputed as well as the surfactants.
3. **ODOUR ABSENCE:** the petroleum solvent vapors have a characteristic odour, not pleasant, that often disturbs also the other workers.
4. **NOT TOXIC:** the petroleum solvent are labeled with toxicity (the Xn symbol).
5. **NOT FLAMMABLE:** the safety increases because they are products to be applied on large surface widths by spraying, paint-brush or immersion in tanks.
6. **LOWER COSTS AND RISKS RELATED TO TRANSPORT AND STORING:** the W.B. can be supplied also like concentrated (not flammable) to be diluted on the place.
7. **COMPATIBILITY WITH WATER DETERGENTS:** the W.B. are compatible with the w.b. detergents, which replaced, for environmental reasons, the chlorinated and petroleum solvents (injurious for man and harmful for ozone).  
Being compatible with the water detergents, penetrant W.B. is compatible with the pieces which arrive wetted from this pre-cleaning.
8. **CERTIFICATES AMS 2644-QPL:** some types and levels are already listed in the List of Qualified products of the Air Force USA.

## **PROCEDURES**

**Red W.B. penetrant** can be used with the usual procedures or following the standard procedures codified in several applicable international specifications. Times and ways of application of red penetrating (NDT ELITE K71B2), water washing, white developer (NDT ELITE D112) and inspection will not modify the habits of operating, bringing moreover the intrinsic advantages of the W.B. over listed.

In picture 1, K71B2 and D112A, are compared on 30 micron Test Panel, to European Spec. EN 3452-3, with qualified equivalents product QPL AMS 2644: Sherwin Dubl Chek DP51 red penetrant and white developer D100 as far as the sensibility.

The used procedure has been the following:

- a. Degreasing with Elite BC1 and Dubl-Chek DR62.
- b. Application of penetrating K71B2 and DP51 with penetration time 5 '
- c. Removal with water.
- d. Application of the developer D112A and D100 with time of development of 5 '

The indications seems completely comparable.

In picture 2, the same products are compared on washability Test Panel 06.230WTP1 with analogous procedure. The appearance of penetrant W.B. K71B2

is more white (better washability), which involves a sensitive advantage on pieces in terms of simplicity and speed of washing, with less volume of used water and less polluting.

**W.B. Fluorescent penetrant** can also be used with the usual procedures or following the standard procedures codified in the several applicable international specifications. On the other side their formulation allow to apply to new procedures, which imply further advantages, mainly if adopted in automatic systems with high productivity; as an example by the producers of light alloy parts for the automotive industry, aeronautics, energy, etc.

These most remarkable advantages regard all the phases of the procedure, that will be singularly analyzed.

## 1. DEGREASING

No more possible to be used for ecological reasons, the chlorinated solvent degreasing (unique step), now you can only use the alkaline detergents water base or a PH neutral (NDT ELITE 20).

A. When an alkaline detergent **is used followed by a petroleum base penetrant**, the degreasing is particularly long and onerous for the necessary system, and its management cost (electric power for the oven and alkaline washing water treatment) and for the number of step, because they need:

1. hot application of alkaline degreaser
2. rinse with clean water + water treatment
3. drying in oven
4. cooling

B. When a neutral detergent **is used (NDT ELITE 20) followed by a petroleum base penetrant**, we obtain a simplification because the rinse and the consequent purification are no more necessary:

1. hot application of neutral degreaser
2. drying in oven
3. cooling

C. When a neutral detergent **(NDT ELITE 20) is used followed by a W.B. penetrant**, we obtain the maximum system simplification, minimization of the operating costs and the reduction of the number of step to one:

1. hot application of neutral degreaser

Subsequently, like over asserted, pieces can be dipped directly in W.B. Penetrant.

## **2. PENETRANT W.B.**

Fluorescent penetrant W.B. ELITE K81B is immediately distinguishable in the use by the lacking of the characteristic odour of petroleum solvents.

Another main characteristic is the lower viscosity: the pieces are covered from the thickness of penetrant, that visually nearly doesn't appear, but it is perfectly effective in finding the defects.

Smaller viscosity means therefore lower penetrant consume and lower polluting loading in the water from washing, constituted moreover from a less polluting penetrant constituents.

The controls of the penetrant in tank are as usual:

- fluorescence with photofluorometer NDT S 291 (ASTM E-1135)
- sensibility and washability with test panel Sherwin PSM 5 (ASTM E-1417)
- content of water with refractometer.

As already said, the penetration times can be maintained, with an important difference in favour of the W.B.

The penetrant W.B. ELITE K81B during the dwell time is concentrating for the evaporation of the water.

If the total time of penetration is, as an example, of 10 ' it is opportune that it is subdivided in 1 ' of immersion more 9 ' of water-drainage, rather than 5' +5 '.

Moreover an extended time of water-drainage of 10 or 20 minutes increases the sensibility of the penetrant in its drying on the surface as increases its concentration.

## **3. WASHING OR EMULSIFYING**

The w.b. penetrating have an optimal washability with water.

The water from washing, even if containing a less polluting burden, must be however treated.

An automatic system dealing a basket every 10' will produce, as an example, medium 80 liters of polluted water at each washing, which means 480 liters hour, which means 3.840 liters in a shift of 8 hours, 7.680 in two shifts and 11.520 liters working on three shifts, like in the light alloy foundries.

The treatment of these water volumes is either not easy and expensive.

So a step of closed circle pre-washing, using hydrophilic emulsifier NDT ER83A (Water Base) that removes and absorbs completely the penetrant in excess, has been introduced.

Successively, the final washing could be realized closed circle or like industrial drainage if locally allowed.

This post-emulsifying “cycle ”applied to a W.B. penetrant save most of acquisition and maintenance costs of a water treatment systems.

#### **4. DRYING**

For the maximum productivity, the use of an oven is advised, but it can also take place at room temperature.

#### **5. DEVELOPMENT**

Fluorescent penetrant W.B. ELITE K81B is self-developing.

This means that:

- A. the developer tank is no more necessary.
- B. It is not necessary to buy and use a developer.
- C. It is not necessary to clean up pieces from the white developer, because they are already washed and dried, ready for the successive working or for the shipment to the customer.

#### **SYSTEMS**

The application of the procedures over described, bring to a remarkable system simplification with consequent lower costs and increase of the production.

The same advantages can be obtained also in existing and working systems, often without modification, but the substitution of the penetrant products with W.B.

Picture 3 illustrates a new automatic system for large productions (3 inspectors at the same time), while in drawing 4 a single operator system is represented for small-medium productions (single operation).

A computer programmed system is used to go through the standard cycle.

The composition standard of the system is following:

1. loading station
2. closed circle degreasing with ELITE 20 ( optional if pieces comes cleaned up)
3. penetrant ELITE K81B
4. dwell time
5. emulsifier ER8A (closed circle)
6. water washing (closed circle)
7. drying in oven (optional)
8. inspection

The limited number of step improves the productivity also working on a single shift of 8 hours because, assuming a time step of 10 ', the first basket will arrive to the inspection after an hour from beginning shift (10 ' x 6 step) and the loading must be stopped an hour before the end of the shift.

The working hours will be therefore 7 for a total of 42 basket, to be multiplied for the number of pieces contained in every basket.

Better conditions can be obtained working on two shifts because the working hours are 15 for a total of 90 basket.

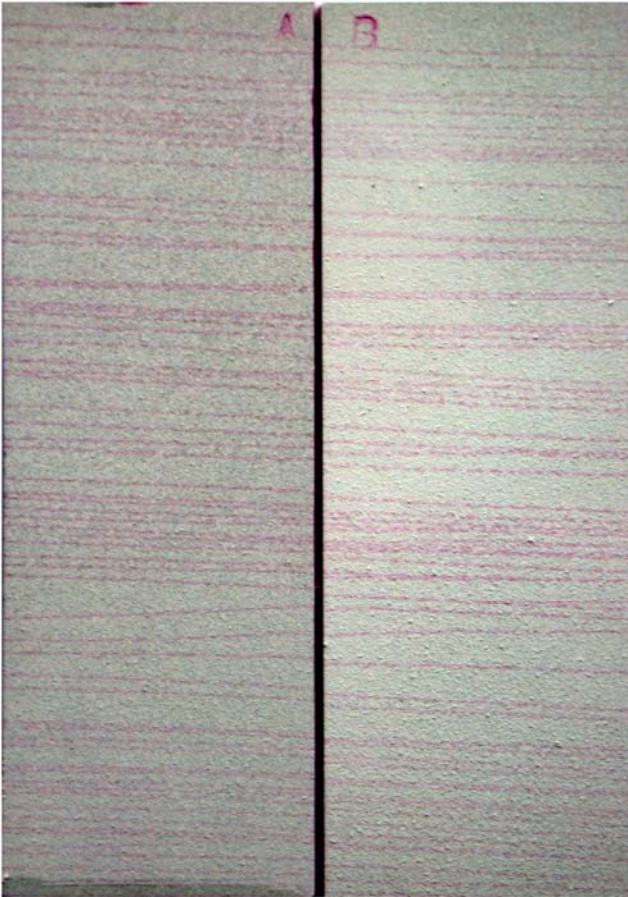
These data are not optimistic but precautionary. As an example the system of picture 3 works with step of 7.5 ' dealing 32 pieces for basket that means 1,800 pieces on a shift, 3000 on two and 6,000 on three shifts.

## **CONCLUSIONS**

Whether you use traditional red penetrant by paint-brush or spray, or fluorescent petroleum base penetrant in existing systems, or you are looking for a new system, a comparative evaluation of the W.B. penetrant will not be a waste of time but it will allow you to estimate the big advantages and the savings.

## **BIBLIOGRAPHY**

- Final Report: water Based Fluorescent Penetrants Ronald G. Sherwin 31 July 1998
- Water Base (Wb) Penetrants Advantages And Limitations Sam Robinson, Randal Goff, Amos Sherwin Asnt Conference 2000
- NDT ITALIANA HANDBOOK LIQUID PENETRANTS
- In Use Penetrant Testing Sherwin Inc
- Instruments for test on NDT ITALIANA penetrant liquid
- The ' PW' penetrant process Sherwin Inc
- Liquid penetrant materials ...Ward Rummel
- Recycling penetrants and rinse water Amos ...Sherwin
- Alternatives dyes and water treatment procedures in inspection penetrants methods Navair systems Command
- Wright-Patterson Air Force Base Materials Laboratory Letter of approval



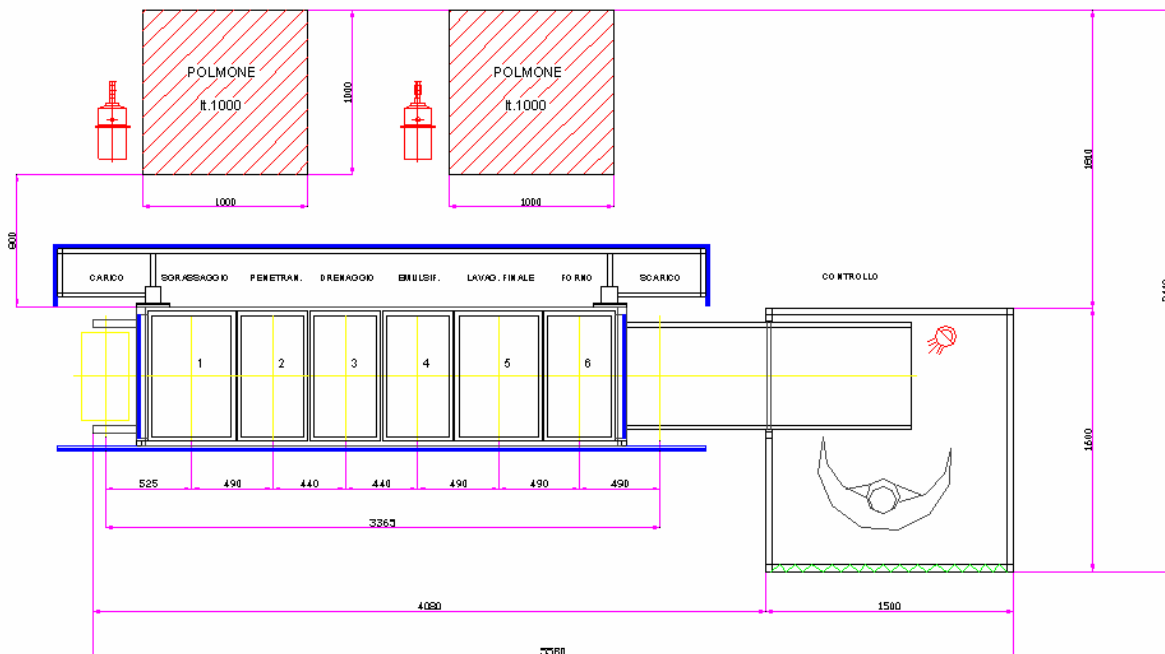
**PICTURE 1**



**PICTURE 2**



**PICTURE 3**



**DRAWING 4**