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<th>Lithographic alcohol eliminator</th>
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<td><strong>Author(s)</strong></td>
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BEFORE WE CAN UNDERSTAND THE BENEFITS OF THE L.A.E. SYSTEM, WE SHOULD LOOK AT THE FEATURES, BENEFITS AND
DRAWBACKS OF ALCOHOL DAMPENING.

ALCOHOL HAS BEEN USED AS A FOUNTAIN SOLUTION ADDITIVE FOR AT LEAST 50 YEARS. WE ALL KNOW THAT ALCOHOL IS A
HIGHLY FLAMMABLE, HIGHLY VOLATILE, AND TOXIC PRODUCT AND IT IS EXPENSIVE. WE ALSO KNOW THAT IN THE PROCESS OF
PRINTING, ALL ALCOHOL WHICH IS INCLUDED IN THE FOUNTAIN SOLUTION AT THE START, IS LOST THROUGH EVAPORATION INTO
THE ATMOSPHERE. SO CONSIDERING ALL THESE NEGATIVE FEATURES OF ALCOHOL, A QUESTION BEGS ITSELF - WHY DO WE USE
IT?

THE SIMPLE ANSWER IS THAT WE USE ALCOHOL BECAUSE OF IT'S TREMENDOUS BENEFITS TO THE LITHOGRAPHIC PRINTING
PROCESS. BY INCLUDING ALCOHOL IN THE FOUNTAIN SOLUTION, WE CAN INCREASE THE SPEED OF PRINTING, IMPROVE THE
QUALITY OF PRINT AND REDUCE PAPER WASTE.

HOW DOES ALCOHOL WORK?

ALCOHOL GIVES US FOUR MAJOR BENEFITS IN THE PRINTING PROCESS:

1. IT REDUCES THE SURFACE TENSION OF THE FOUNTAIN SOLUTION, THUS PROVIDES A FAR MORE EFFICIENT AND FASTER
   WETTING OF THE PRINTING PLATE.

2. IT INCREASES THE DEGREE OF HYDROGEN BONDING OF THE WATER MOLECULES RESULTING IN INCREASED VISCOSITY OF
   WATER. THE WATER WITH HIGHER VISCOSITY TRANSFERS BETTER THROUGH THE ROLLER TRAIN OF THE DAMPENING SYSTEM,
   WHICH RESULTS IN GREATER AMOUNT OF FOUNTAIN SOLUTION BEING DELIVERED TO THE PRINTING PLATE.

   THE COMBINED EFFECTS OF DELIVERING MORE WATER TO THE PRINTING PLATE AND THE WATER SPREADING ON THE
   SURFACE OF THE PLATE FASTER, GIVES A MUCH MORE EFFECTIVE AND EFFICIENT DAMPENING.

   BY INTRODUCING ALCOHOL INTO THE FOUNTAIN SOLUTION IN COMBINATION WITH EFFICIENT DAMPENING SYSTEM SUCH AS
   DAHLGREN (WHICH WAS DEVELOPED BY HEIDELBERG IN THE 40'S FOLLOWED BY SOME OTHER DEVELOPMENTS SUCH AS DUOTROL,
   MILLERMEETER, HARRIS AND OTHER SYSTEMS) THE SPEED, QUALITY AND THE EFFICIENCY OF THE PRINTING PROCESS HAS
   INCREASED TREMENDOUSLY. THE SPEED OF PRINTING HAS MORE THAN DOUBLED. BEFORE THE INTRODUCTION OF ALCOHOL
   DAMPENING, THE MAXIMUM PRESS SPEEDS OF A SHEETED PRESS WERE 7-8,000 IMPRESSIONS PER HOUR WITH THE
   INTRODUCTION OF ALCOHOL AND ALCOHOL DAMPENING SYSTEMS THE SPEED OF PRINTING COULD INCREASE TO 13, 14 OR EVEN
   18,000 IMPRESSIONS PER HOUR. HOW DOES ALCOHOL DO THIS?
We mentioned that alcohol increases the hydrogen bonding of water. What does that mean? Well, water is represented by a chemical symbol of H\textsubscript{2}O. If we consider water as a single molecule, represented by the symbol of H\textsubscript{2}O and we look at its physical properties, we would find that such water would be a gas at ambient temperature and therefore totally useless to us and to nature.

The reason water occurs in nature as a liquid is that the water molecules combine together through a phenomena known as hydrogen bonding and form clusters, which increase the viscosity of water to the degree that it becomes a liquid and also increase its boiling point so that water boils at 100°C and is a liquid at ambient temperature.

It is a known fact that by adding alcohol to water the level of (hydrogen bonding) of water molecules is increased. The degree of clustering of the water molecules is increased and therefore the viscosity of water increases. We know that water with higher viscosity is carried more efficiently by the roller train of the printing press and thus alcohol dampening delivers more water to the plate, while the surface tension reducing effect of alcohol on water ensures that the wetting of the plate is also more efficient. Other benefits of alcohol are:
Effect of Alcohol - Cooling

- Cooling of the dampening system and of the plate through evaporation of alcohol
  - More stable ink/water balance
  - Higher water viscosity
  - Sharper print

Alcohol evaporates in the process of dampening. If we start with 13-15% of alcohol in the fountain solution tray, by the time this mixture reaches the printing plate, most of the alcohol evaporated and we will only have 1-2% of alcohol in the fountain solution on the plate and by the time this mixture together with ink is transferred to the printing blanket, alcohol would have evaporated altogether.

There are two benefits from this phenomena:

(A) Alcohol performed its task and evaporated and is no longer in the system. Therefore, it does not interfere with the rheology of the ink. If printing ink picked up excessive amounts of alcohol or other solvents, it would become much more water miscible, its tack would be reduced and therefore it would cause problems such as emulsification, piling, ink feedback through the dampening system etc. Also, because alcohol is evaporating in the process of dampening, it is removing the excessive heat generated by friction during the printing process and therefore it cools the system. So, the entire system, including the rollers, plate and the blanket are running cooler at lower temperature. The ink-water balance is wider, the viscosity of the ink is more constant, printing a sharper dot, the plate cleaning is much faster, so again the alcohol aids the efficiency of printing.

It can easily be demonstrated that if we remove the alcohol from the fountain solution we have problems. Every printer knows that by reducing the alcohol level, he has to dial up more water. It doesn’t mean that he’s running more water, the fact is he has to increase the water setting on the press just to maintain sufficient water supply to the plate. Running without alcohol the water supply will be reduced, often resulting in catch-up, or tinting problems. The ink-water balance will be more difficult to maintain, leading to increase in piling and emulsification. The printing will be far less efficient.

By removing the alcohol from the fountain solution, its viscosity will decreases. The dampening rollers will therefore carry less water to the plate! The surface tension of the fountain solution will increase, resulting in less efficient plate wetting. The only way to compensate for these deficiencies is to reduce the speed of the press which in today’s environment is totally unacceptable.
SO, CONSIDERING ALL THESE FACTORS, OBVIOUSLY IT WOULD BE VERY DESIRABLE TO DEVELOP A FOUNTAIN SOLUTION WHICH WOULD CONTAIN CHEMICAL SUBSTITUTES, BEHAVING SIMILARLY TO ALCOHOL. IN OTHER WORDS, CHEMICAL SUBSTITUTES WHICH WOULD GIVE US SIMILAR PERFORMANCE TO ALCOHOL, WITHOUT THE DRAWBACKS OF ALCOHOL. DEVELOPMENT OF SUCH A PRODUCT HAS BEEN THE AIM OF EVERY CHEMISTRY MANUFACTURER IN THE WORLD, INCLUDING OUR OWN COMPANY AND EVERY CHEMISTRY MANUFACTURER IN THE WORLD HAS SOME DEGREE OF SUCCESS WITH SUCH A PRODUCT.

I AM SURE, THAT EVERY PRINTER HAS TRIED AN ALCOHOL SUBSTITUTE AND EVERY PRINTER CAN TELL US STORIES OF SUCCESSES AND FAILURES WITH SUCH PRODUCTS. UNFORTUNATELY, MOST ALCOHOL SUBSTITUTES ARE SUCCESSFUL IN MATCHING ONLY ONE FEATURE OF ALCOHOL: THE REDUCTION OF SURFACE TENSION. THERE ARE NUMEROUS SOLVENTS AND SURFACTANTS AND THEIR BLENDS, WHICH WILL MORE THAN ADEQUATELY MATCH THE SURFACE TENSION REDUCTION OF ALCOHOL.

UNFORTUNATELY, NONE OF THESE SUBSTITUTES WILL INCREASE THE DEGREE OF HYDROGEN BONDING OF WATER TO THE SAME EXTENT AS ALCOHOL DOES AND THEREFORE THE ROLLER TRAIN OF THE DAMPENING SYSTEM WILL DELIVER CORRESPONDINGLY REDUCED LEVEL OF FOUNTAIN SOLUTION TO THE PRINTING PLATE. NONE OF THE KNOWN ALCOHOL SUBSTITUTES SUCH AS GLYCOL-ETHERS, GLYCOLS, POLYGLYCOLS AND VARIOUS SURFACTANTS WILL INCREASE THE DEGREE OF HYDROGEN BONDING OF WATER TO THE SAME EXTENT AS ALCOHOL. IN THIS RESPECT ALCOHOL IS TOTALLY UNIQUE. FURTHER, THESE SUBSTITUTES DO NOT EVAPORATE DURING THE PRINTING PROCESS. IF WE START WITH SAY 5% OF ALCOHOL SUBSTITUTE IN THE FOUNTAIN SOLUTION, WE END UP WITH 5% OF ALCOHOL SUBSTITUTE ON THE ROLLER TRAIN, WITH 5% SUBSTITUTE ON THE PRINTING PLATE AND WITH 5% ALCOHOL SUBSTITUTE ON THE BLANKET. THE ALCOHOL SUBSTITUTE WILL BE ABSORBED BY THE PRINTING INK AND THE PROPERTIES OF THE INK WILL BE OFTEN DRASTICALLY ALTERED. THE VISCOSITY AND THE TACK OF THE INK WILL BE SIGNIFICANTLY REDUCED, THE INK WILL BECOME MUCH MORE WATER MISCIBLE AND VERY OFTEN IT WILL EMULSIFY TO A FAR GREATER DEGREE THAN IS DESIRABLE. THE EMULSIFIED INK WILL FEED BACK THROUGH THE DAMPENING SYSTEM CAUSING PROBLEMS WHICH ALL PRINTERS ARE VERY FAMILIAR WITH.

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ANY ALCOHOL SUBSTITUTE MIGHT WORK WITH ONE INK AND FAIL WITH ANOTHER OR MAY WORK WITH ONE STOCK AND FAIL WITH ANOTHER. FOR THESE REASONS ALCOHOL SUBSTITUTES FOUND A LIMITED ACCEPTANCE AND LIMITED USEFULNESS IN ALCOHOL DAMPENING.

ANOTHER IMPORTANT FACTOR IS TOXICITY. ALTHOUGH ALCOHOL SUBSTITUTE ARE FAR LESS VOLATILE THAN IPA, MOST OF THEM ARE FAR MORE TOXIC THAN ALCOHOL. MANY GLYCOL ETHERS ARE POTENTIAL CARCINOGENS WHICH ARE RAPIDLY ABSORBED THROUGH THE SKIN AND CAN CAUSE ILLNESSES AS WELL AS SKIN IRRITATION PROBLEMS.
IN CONTRAST, THE L.A.E. IS A NON CHEMICAL ENVIRONMENTALLY FRIENDLY ALTERNATIVE TO ALCOHOL.

IT WILL BE EASIER TO EXPLAIN HOW THE L.A.E. WORKS, IF WE CONSIDER THE WORKINGS OF A SIMPLE ELECTRICITY GENERATOR. WE ARE ALL FAMILIAR WITH GENERATORS. WE HAVE THEM IN OUR CARS, AND WE HAVE LEARNED ABOUT ELECTRICITY GENERATING AT SCHOOL. IN SIMPLE TERMS, AN ELECTRICITY GENERATOR CONSISTS OF A MAGNETIC HOUSING INSIDE OF WHICH IS A ROTOR. THE ROTOR CONSISTS OF A COIL OF COPPER WIRE, WHICH ROTATES BETWEEN THE MAGNETS CUTTING THROUGH THE MAGNETIC FIELD AND AS IT CUTS THROUGH THE MAGNETIC FIELD, ELECTRICITY IS BEING GENERATED.

THE QUANTITY OF ELECTRICITY GENERATED DEPENDS ON THREE FACTORS:

1. **THE STRENGTH OF THE MAGNETIC FIELD (HOW POWERFUL THE MAGNETS ARE)**
2. **HOW FAST THE ROTOR SPINS BETWEEN THE MAGNETS**
3. **HOW MANY STRANDS OF COPPER WIRE ARE CONTAINED IN THE COIL OF THE ROTOR.**

THE STRONGER THE MAGNETS, MORE ELECTRICITY IS GENERATED, LIKewise WITH FASTER ROTATION OR MORE COPPER IN THE ROTOR, THE MORE ELECTRICITY WILL BE GENERATED. WE CAN USE THIS ANALOGY TO EXPLAIN THE L.A.E. DEVICE.
L.A.E. - (Design)

- **Effect:**
  - Increased level of hydrogen bonding.
  - Strong ionisation of the electrolytes in the fountain solution.
  - Strong attraction of the negatively charged fountain solution to the positive (Aluminium) plate.

- **Common Electrolytes present in Fountain Solutions:**
  - Phosphates
  - Nitrates
  - Citrates
  - Carbonates
  - Other


1. **(A)** THEIR STRENGTH IS NOT SUFFICIENT FOR MANY APPLICATIONS AND
2. **(B)** THEY ARE NOT PERMANENT ENOUGH.

THEIR MAGNETIC FIELD WILL DISSIPATE WITH TIME AND THE DISSIPATION OF SUCH FIELD WILL BE ACCELERATED BY HIGHER TEMPERATURE. IN CONTRAST, THE L.A.E. MAGNETS ARE NOT SUBJECT TO FIELD FLUCTUATION DUE TO TEMPERATURE AND THEIR MAGNETIC FIELD STRENGTH IS EXTREMELY CONSTANT. THEY LOSE NO MORE THAN 0.1% OF THEIR MAGNETIC STRENGTH OVER 100 YEARS. THEREFORE, WE CAN_ASSUME THAT THE L.A.E. DEVICE, AS SUPPLIED TO THE PRINTER IS CONSTANT AND WILL NOT DIMINISH WITH TIME. IT IS THEREFORE EASY TO SEE THAT THE EFFICIENCY OF THE L.A.E. SYSTEM CAN BE INCREASED BY:

1. **(A)** INCREASING THE SPEED OF CIRCULATION OF THE FOUNTAIN SOLUTION THROUGH THE UNITS
2. **(B)** AND / OR BY OPTIMISING THE COMPOSITION OF THE FOUNTAIN SOLUTION AND MORE SPECIFICALLY, BY OPTIMISING ITS ELECTROLYTE COMPOSITION.

THE EFFECTIVENESS OF THE L.A.E. SYSTEM DEPENDS ON THE SALT OR ELECTROLYTE COMPOSITION OF THE FOUNTAIN SOLUTION. THEREFORE, BY SELECTING MORE SUITABLE SALTS, WHICH ARE CAPABLE OF STRONGER IONISATION, WE WILL PRODUCE A BETTER RESULT. WE CAN SAY WITH CONFIDENCE THAT THE L.A.E. WILL WORK WITH EVERY COMMERCIALLY AVAILABLE FOUNTAIN SOLUTION. ALL COMMERCIALLY AVAILABLE FOUNTAIN SOLUTIONS CONTAIN VARIOUS SALTS OR AS THEY ARE ALSO KNOWN ELECTROLYTES AND THEREFORE THEY WILL IONISE IN A MAGNETIC FIELD. HOWEVER, BECAUSE THE COMPOSITION OF VARIOUS FOUNTAIN SOLUTIONS VARIES FROM EACH OTHER, THE EFFECT OF THE L.A.E. TREATMENT ON THEM WILL ALSO DIFFER. THEIR EFFECTIVENESS IN REDUCING THE ALCOHOL ON THE PRESS WILL ALSO DIFFER. HOWEVER, PRACTICAL TESTS ON NUMEROUS PRESS INSTALLATIONS DEMONSTRATE THAT IN EVERY CASE, IRRESPECTIVE OF THE FOUNTAIN SOLUTION, WE CAN REDUCE THE ALCOHOL LEVEL ON THE PRESS BY MINIMUM OF 80%, WITHOUT ANY ADVERSE EFFECTS ON THE PRESS PERFORMANCE OR ON THE PRINT QUALITY.


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WHAT HAPPENS WHEN FOUNTAIN SOLUTION PASSES THROUGH THE MAGNETIC FIELD OF THE L.A.E. UNIT? IT HAS BEEN SHOWN THAT AQUEOUS SOLUTIONS WHEN SUBJECTED TO POWERFUL MAGNETIC FIELDS, WILL HAVE AN INCREASED LEVEL OF HYDROGEN BONDING, SIMILAR TO THE EFFECT ACHIEVED BY ADDING ALCOHOL TO FOUNTAIN SOLUTION. THE LEVEL OF HYDROGEN BONDING WILL PROPORTIONALLY INCREASE THE VISCOSITY OF THE WATER AND THEREFORE THE ABILITY OF THE ROLLERS OF THE DAMPENING SYSTEM TO CARRY GREATER QUANTITY OF WATER OR FOUNTAIN SOLUTION TO THE PRINTING PLATE.

THE SALTS PRESENT IN THE FOUNTAIN SOLUTION OR AS WE REFERRED TO THEM EARLIER, THE ELECTROLYTES WILL IONISE. THIS IONISATION PROCESS CAN EASILY BE DEMONSTRATED BY LOOKING AT A MOLECULE OF TRISODIUM PHOSPHATE. THE TRISODIUM PHOSPHATE WHEN SUBJECTED TO MAGNETIC FIELD IN AN AQUEOUS SOLUTION WILL DISSOCIATE OR IONISE IN THREE STAGES:


![Ionisation Process](image)

- Negative ions in the fountain solution are strongly attracted to the positive aluminium plate.
- Negatively charged fountain solution
- Effective and efficient plate wetting.
- Positively charged anodised aluminium printing plate.

(B) REDUCED INK EMULSIFICATION. INK TAKING UP A CERTAIN PERCENTAGE OF WATER IS VERY DESIRABLE AND AN ESSENTIAL FEATURE FOR SUCCESSFUL LITHOGRAPHIC PROCESS. PRINTING INKS ARE FORMULATED TO TAKE UP 40-60% WATER DURING INTERACTION WITH THE FOUNTAIN SOLUTION ON THE PRESS.


(D) RETARDATION OF BACTERIAL GROWTH IN THE FOUNTAIN SOLUTION. ALL BACTERIA CAN BE DIVIDED INTO 2 MAIN GROUPS - GRAM POSITIVE AND GRAM NEGATIVE. THIS DIVISION IS BASED ON THE TYPE OF THE SMALL DISCREET ELECTRICAL CHARGE PRESENT ON THE BODIES OF BACTERIA. THE GRAM POSITIVE BACTERIA CARRY A POSITIVE CHARGE AND THE GRAM NEGATIVE, A NEGATIVE CHARGE RESPECTIVELY. IT HAS BEEN SUGGESTED THAT BY A POWERFUL MAGNETIC FIELD, WILL DISRUPT THESE MINUTE ELECTRICAL CHARGES ON THE BODIES OF BACTERIA RESULTING IN RETARDATION OF THEIR ABILITY TO REPRODUCE. IT IS NOT FULLY UNDERSTOOD HOW THE MAGNETIC FIELD INTERACTS WITH THE BACTERIA, BUT IT CAN EASILY BE DEMONSTRATED THAT IN PRACTICE MAGNETIC FIELD WILL REDUCE BACTERIAL CONTAMINATION IN AQUEOUS SYSTEMS. AGAIN, THE BENEFIT TO THE PRINTER IS A CLEANER, LESS CONTAMINATED DAMPENING SYSTEM, WHICH CAN USE FOUNTAIN SOLUTIONS WITH REDUCED LEVELS OF CHEMICAL BIOCIDES.
So far, we have been concentrating on describing the effect of the L.A.E. as an alcohol reduction device on presses equipped with alcohol dampening systems. Indeed, the L.A.E. system has been primarily developed as an alcohol reduction device however, since its introduction some of our large customers as well as press manufacturers (such as M.A.N.) have also investigated the effect of the L.A.E. device on the performance of conventional, non alcohol dampening systems, such as brush and turbo dampening. All such tests as well as actual commercial installations showed definite benefits which can be summed up as follows:

- Increased efficiency of the dampening system, resulting in substantially reduced water settings on the press.
- More even distribution of the fountain solution on the plate.
- Increased print quality and reduced waste.

We know that the brush dampening system does not deliver an even and continuous level of fountain solution to the plate. The fountain solution is delivered in a wave pattern with a corresponding hills and valleys, causing patterns of the over and under dampening on the surface of the plate. Normally, the dwell time between each impression is sufficient for this uneven water level on the plate to level out. But, if the press speed is high we can often see a "tram line" pattern occurring, especially in the high density, fine screen areas. Likewise, the turbo dampening system, delivers water to the plate in the form of droplets, which are relatively large in size. The effectiveness of such system again depends on there being sufficient time between each impression, for the water to level out on the surface of the plate. Like in the case of brush dampening, the limiting factor to the effectiveness of the turbo dampening system is the press speed, which can never be as high as achieved with presses equipped with alcohol dampening systems. When presses using conventional dampening systems are equipped with L.A.E. units, the dampening system will become more efficient, performing more like an alcohol dampening system.

The brush dampening system will deliver a much more even layer of water to the plate and in case of turbo dampening system, the size of the water droplets will be considerably reduced, giving a better plate coverage. The resulting benefits are running with substantially reduced water, possibility of increased press speeds, longer rungs between wash-ups, less paper waste and better print quality.
IN SUMMARY

THE L.A.E. IS A LOW COST, NON CHEMICAL, ENVIRONMENTALLY FRIENDLY SYSTEM, WHICH OFFERS A COST EFFECTIVE ALTERNATIVE TO ISOPROPANOL WITH ADDED BENEFITS OF CLEANER RUNNING, BETTER PRINT QUALITY AND REDUCED WASTE.

THE L.A.E. UNITS ARE VERY SIMPLE TO INSTALL. THEY DO NOT REQUIRE ELECTRICAL CONNECTIONS AND ONCE INSTALLED, THEY ARE TOTALLY MAINTENANCE FREE AND WILL PERFORM DURING THE ENTIRE LIFE OF THE PRESS.

HOWEVER, IT MUST ALSO BE POINTED OUT THAT THE L.A.E. SYSTEM IS NOT A CURE FOR ALL. IT WILL NOT COMPENSATE FOR INCORRECTLY SET PRESS, FOR FAULTY ROLLERS, POOR WATER QUALITY OR INSUFFICIENT PRESS MAINTENANCE.

THE BASIC PRINCIPALS AND REQUIREMENTS OF LITHOGRAPHIC PRINTING STILL APPLY, AND PROVIDED THAT THESE ARE OBSERVED, THE L.A.E. SYSTEM WILL GIVE THE PRINTER A COST EFFECTIVE, ALTERNATIVE TO ALCOHOL WITH A CLEANER, HEALTHIER WORKING ENVIRONMENT AS WELL AS BETTER PRINT QUALITY AND INCREASED PRODUCTIVITY.