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Tests to Verify the Results of Treatment with an Ultraviolet (UV) Ray Procedure on Various Types of Fabric

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Abstract

The project "VERIFICATION TESTS OF THE RESULTS FROM THE TREATMENT OF AN ULTRAVIOLET (UV) RAY PROCEDURE ON VARIOUS TYPES OF FABRIC" by the Company RTP RIFINZIONE TESSILE PRATESE SRL, developed in 2016, is placed in an extremely innovative context; in fact, both for the specific structure and corporate philosophy of the Company, linked to innovation, a new innovative product has been created in accordance with the criteria set out in the Oslo and Frascati manuals. As can be seen from the experimentation, the elements of innovation are linked to various components that have determined a series of preliminary studies and tests for their operation. The innovative elements are enclosed in various specific components which are listed below as an example:
One of these particular "treatments" of the fabrics consists in the use of a machine purchased by R.P.T. S.r.l. a few years ago as a "prototype" (called SUN WASH), which allows various types of fabrics to more or less intense ultraviolet rays (UV rays) and to vary the duration of the process, in such a way as to intervene on the shade of the colors <le fabrics. R.T.P. S.r.l. has therefore designed and developed a program of experimental tests aimed at determining what type of results are

obtained on various types of fabric through the different UV ray treatment methods that the machine is able to operate.

Keywords: Sustainability, Ultraviolet, Prototype, Fabric

1. Introduction

The dissemination and transfer of the results obtained were conducted in line with the guidelines of the Frascati Manual, ensuring that all sensitive information and know-how developed during the research and testing phases were carefully protected and only partially shared to safeguard the company's competitive advantage. Throughout the project life cycle, the Company rigorously and methodically documented each phase of the technological development processes, collecting evidence in the field through detailed reports and technical sheets, which were integrated into a comprehensive document attached to the final report.
Furthermore, the internal dissemination plan of the project was oriented to maximize the appropriation of the skills developed by the technical team and management resources, enabling a continuous application and optimization of innovative technologies for an environmentally sustainable process. This strategy made the company more competitive, capable of quickly responding to the challenges of the sector and fully exploiting the technical innovations acquired.
The “rameuse” uses a large amount of thermal energy, and consequently for some years R.T.P. S.r.l. has equipped itself with smoke purification and heat recovery systems in order to meet the emission limits imposed by current legislation and at the same time recover part of the thermal energy used by the “rameuse”.
One of the phases of the smoke purification system consists of the ionization and reduction of pollutants by means of plate electrofilters. Over the years, the maintenance of these electrofilters has proven to be particularly difficult and expensive, as there have been frequent problems with worn components inside the electrofilter cells, with significant and in the long run unsustainable maintenance costs.
R.T.P., supported by the company that had previously supplied and installed the fume purification and energy recovery systems, therefore designed, tested and implemented in 2015 an intervention on the electrical panels for the management of the electrofilters containing traditional Duplicators and Transformers, replacing them with electrical panels equipped with electronic cards for the generation of high voltage, in order to limit the costs and maintenance times of the electrofilters. The high voltage cards installed generate voltages of 5,000 and 10,000 V, allowing greater continuity of the electrical power supply, thus increasing the efficiency of the system as a technology.

2. Materials and methods

Below is a representative figure of the machine:

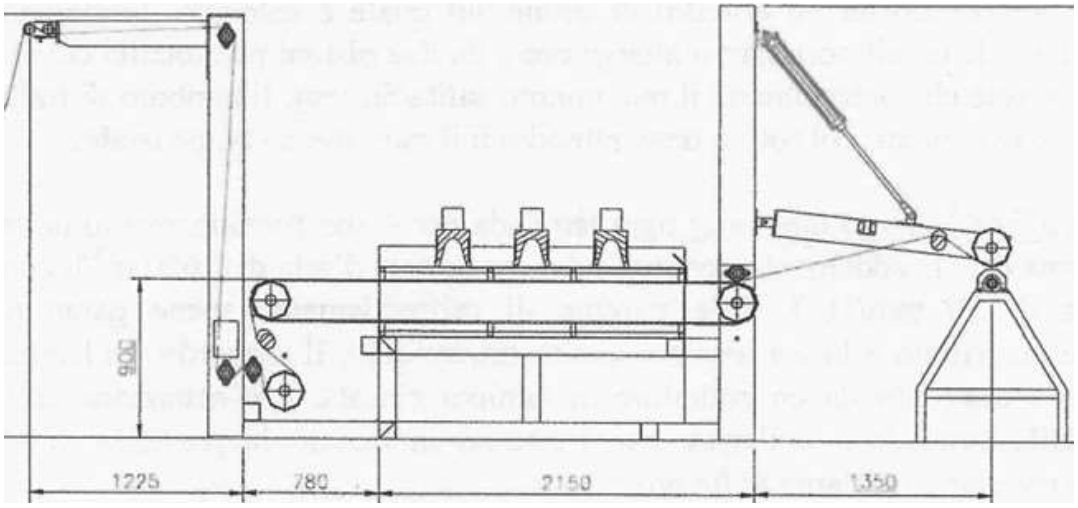

Figure 1. Description of the machine

This part includes an aluminum roller to accompany the fabric, a towing drum to pull the fabric from the roll, and an adjustable curved spreader (banana) that has the function of "stretching" and thus removing any creases from the introduced fabric. The fabric is brought onto the "carpet" on which it is subjected to UV treatment by means of two towing cylinders: one motorized at the exit and one "idle" at the entrance (the movement is managed by PLC like the entire line).
SUN WASH unit: it consists of a steel structure essentially made up of:
• SUN WASH lamps: there are 3 medium pressure air-cooled mercury vapor arc lamps (lasting approximately 1090 hours). The power of each lamp is 120 W/cm. The body of the lamp is made of a tube that is 90% transparent to UV rays and resistant to normal operating conditions (the surface temperature of a lamp in operating conditions is between 600 and 800 °C);
• SUN WASH housing: lamp holder in extruded aluminum with heat sink and equipped with a shutter suitable for lamps, aluminum sheet cover. There are 2 holes for connecting the cooling fan and ozone removal:
- lamp power supplies: each lamp is equipped with a 400V/50Hz power supply;
- single-phase, variable power output, 50% stand-by mode, regulation of
- AC/DC power, variable impedance, power factor correction capacitors, self-resetting thermal protector, input and output terminal blocks;
- heat dispersion box: around and under the housings there is a containment box with the dual function of protecting from the escape of light (which could be dangerous for

the eyes) and collecting and - via a connection to the ventilation system - disposing of it outside.

Reel: the tangential reel has the function of rolling the outgoing fabric onto a roll, and is made up of 2 oscillating arms fixed directly onto the output. The system is completed by a towing cylinder on which the gearmotor is directly keyed, by a curved widening cylinder and by two pneumatic pistons controlled by solenoid valves that determine the up/down movement. The towing drum comes into direct contact with the roll, transmitting the tangential movement to it.
Lamp cooling system: each lamp, for its operation, requires a cooling system consisting of an air flow rate of 1,600 m^3/h with a prevalence of 50 mm/H_2O. This cooling system is guaranteed by a low voltage, high efficiency centrifugal fan. The connection between the lamps and the fan is made up of a galvanized sheet metal collector. The evacuation of the air sucked in by the lamps is connected to the outside since the presence of ozone prevents it from pouring into the work area.
Heat extraction system: there is an extractor with the function of dispersing the heat derived from any high temperatures that could be generated inside the box. Three thermocouples detect the temperatures inside, while two other infrared ones read the temperature on the outgoing fabric. The hot air sucked in by the box is expelled outside.

3. Results

Various types of fabric were subjected to a UV treatment by passing them through the machine called SUN WASH, verifying with what intensity and modality this process is able to alter the shade of the color of the fabrics themselves. It should be noted that, since the machine is equipped with 3 lamps, it is possible to decide how many lamps to turn on for each treatment as well as establish the power of each lamp (the power of each lamp is in fact adjustable from a minimum of 60% up to a maximum of 100%); it follows that for each type of fabric it is possible to obtain different results depending on the different treatment methods (the number of lamps in operation and the power of each of them can change).
The results of the tests were the following:
- degradation of the intensity of the active dyes used on cellulose fibers (cotton, linen, viscose) and on silk (simulating the effect of a fabric hung out in the sun for a long time), while it has no effect on pigments or jeans. Numerous tests have been carried out to create areas of more or less "degraded" colour (thus obtaining "designs" of different colours within the same garment) and using drops of water (which intercept the UV rays and limit their effect) to obtain the "spotted" effect;
- numerous tests with wool fabrics have instead established that, by subjecting the fabric to the treatment before its colouring, it is possible to give the silk a better "hold" of the colour, thus obtaining results substantially similar to the "chlorination" process

to which silk is usually subjected when one wants to give the fabric particularly bright colours (without having, obviously, all the pollution consequences that the "chlorination" process entails).

4. Conclusion

The Company's project involved the creation of a team selected with rigor and attention to the skills needed to tackle an advanced experimentation process in the Company's reference sector. The company chose its personnel with a precise assessment of their operational and theoretical skills, favoring people with decision-making ability and in-depth knowledge of company dynamics. The team was formed following a logic aimed at maximizing the contribution of know-how, transferring consolidated experience in relevant sectors into the experimentation and contributing to the achievement of objectives through a structured and methodological approach. The team was configured to ensure an ideal balance between theoretical knowledge and practical skills, creating a flexible and dynamic work environment, where the contribution of each member is valued and oriented towards solving experimental challenges. In selecting the group, particular attention was paid to the ability of individuals to tackle and solve complex problems and to their inclination to manage changing situations, with a rapid decision-making approach based on technical data and specialist knowledge. This has allowed us to build a versatile and resilient team, capable of responding adequately to the specific needs of each phase of the experimentation, maintaining a high level of quality and ensuring constant progress towards the objectives. The company has also favored a team structure that integrates diversified skills, including people with various professional and personal backgrounds, an element that has enriched the experimentation process and has allowed us to tackle problems with multiple approaches, offering different perspectives and helping to strengthen the effectiveness of the proposed solutions. One of the fundamental objectives in defining the team was to promote a culture of collaboration, where the continuous exchange of knowledge represents a strategic added value. Each member is encouraged to express and share their technical contribution and to support colleagues, making the team a context in which learning is constant and adaptive. The company has placed emphasis on the inclusion of individuals with a strong predisposition for continuous updating, thus ensuring that the team is always in line with the most recent technical and scientific developments in the reference sector. In addition, the project was developed in collaboration with other entities, both to broaden the field of available knowledge and to ensure that the technologies and methodologies adopted in the experimentation were fully capable of meeting the standards required in the reference sector.
This synergy with other entities has further strengthened the team's capabilities, allowing it to develop solutions that integrate best practices and that stand out for their effectiveness and sustainability in production processes.

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