

Fig. 1 .... Control of Water Temperature by a Thermostatic Mixing Valve

following typical examples that may be encountered in color photo-finishing plants.

Plant Number 1 has two color film processors, each using 8 gpm of water; two color print processors, using 10 gpm each; and a system of 3½ gal tanks for small-volume film processing, using 8 gpm. Total water flow is 44 gpm.

Plant Number 2, with a smaller volume of business, has one color film processor, 8 gpm; a 3½ gal tank system for other color films, 8 gpm; and two 3½ gal tank systems for color print processing, 6 gpm each. Total water flow for this plant is 28 gpm.

In order to secure the maximum flow through the most accurate mixing valve, nearly equal quantities of cold and hot water must be flowing through it.

For example, when 4 gpm of 75 F water is required, the ideal situation calls for 2 gpm of cold water and 2 gpm of hot water entering the valve. Manufacturers of these valves recommend that both the hot and cold water being supplied should have a temperature differential of *at least* 15 F deg from the control point desired. It is suggested that a slight safety margin be added to this figure by maintaining the hot water being fed to the control valve at 95 F, while the cold water is supplied at 55 F. Thus, if 44 gpm of 75 F water are required, 22 gpm of 95 F water and 22 gpm of 55 F water should be supplied. These requirements eliminate the possibility of supplying tap water directly to the mixing valve in most localities.

In plants where a separate water heater is used for the finishing plant, it will be a fairly simple matter to set the water heater thermostat at the 95 F level. However, where a central water heating plant is in use for several different purposes, it may be desirable to heat the water to a much higher point. In this case, the hot water may be combined with cold through an automatic tempering valve to supply the 95 F water required.

Fig. 2 is a diagram of a fully automatic temperature-control system designed for a large water jacket. As the temperature in the water jacket varies, the thermo-regulator bulb activates relays which in turn operate solenoid valves on either the hot or cold water line. A needle valve for throttling, used in conjunction with each solenoid valve, greatly increases its efficiency.

The waste water from either the manually controlled or automatic system may be flowed through a heat exchanger to help cool or warm the incoming water, thus effecting a saving in refrigerated or heated water. To prevent any possible stratification and to ensure evenness of temperature throughout the tank, the water is recirculated by means of a small pump, as indicated by the broken lines on Fig. 2.

The mixing valve and recirculating systems may be combined for greatest accuracy and economy. One company recommends that a thermostatic mixing valve be used to supply tempered water to all tanks except the developer tank. After leaving the mixing valve, the water is distributed into the solution-tank jackets and thence to the wash tanks, from which it drains and is discarded. The water in the developer tank jacket is recirculated through a temperature control unit which has an air-cooled condenser and a ¼ ton refrigeration unit equipped with standard limit controls, two 500-watt immersion heaters, heat exchanger, pump and a thermostat operating on a temperature differential of ±0.2 F deg. This unit maintains the developer solution temperature within the close limits required in color processing. It is an economical

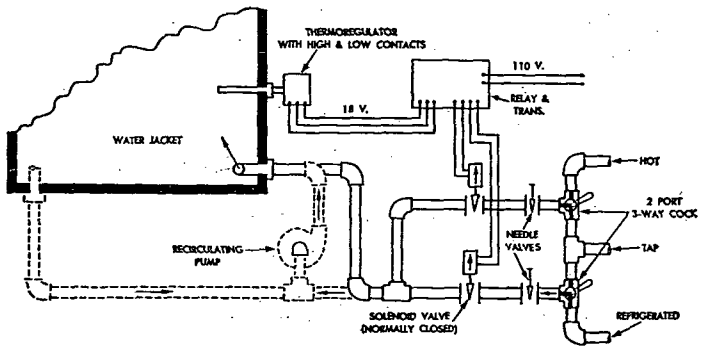


Fig. 2 .... Automatic Water Temperature Control in a System Equipped with Recirculating Pump

unit to use, because it is a completely closed system with no connection to hot or cold water lines.

After processing, the film must be dried as quickly and economically as possible without damage to the emulsion or support material. Drying can be accomplished by the application of air, hot air, radiant heat, conditioned air or a combination of these. It is recommended that color films be dried in a drying cabinet at a temperature not exceeding 110 F. In one type of cabinet, warm air is filtered and circulated through the drying area. The moisture-laden air is then exhausted through a vent to the outside. The drying time can be reduced by half or more if a dehydrator is installed in the cabinet. In this system the moisture-laden air from the drying area is filtered and returned to the dehydrator, where the moisture is removed by condensation, and the cool air is reheated on its way back to the drying chamber. Color films can be dried in 15-20 min by this method.

Printing Photographic Materials

Close control of room temperature and humidity are not necessary in most small-scale printing operations. It is desirable, however, to keep dust and dirt to a minimum. The use of filters and, if possible, conditioned air is advantageous in this operation.

The electronic printers used in making color prints in photo-finishing plants should be operated under constant temperature and humidity conditions. It is recommended that printer rooms be air conditioned to a temperature between 70 and 80 F and a relative humidity not higher than 50 percent. The circulation of conditioned air in the immediate vicinity of the printer should not be restricted by booths surrounding the printer or by directional flow of the air due to location of duct outlets and returns. Heat generated by the lamphouse of the printer must be dissipated rapidly to prevent its affecting the sensitivity of the phototubes which control color balance.

Excess humidity or condensed moisture can cause electrical leakage from several of the components and will result in erratic printing times. Air conditioners with built-in humidity controls are recommended for this reason. The air conditioning should be operated 24 hr a day, 7 days a week, to prevent the condensation of moisture on the components.

In printing motion pictures, the negative film and raw positive film are passed continuously together at high speed through the printer. For best results, the printing room should be maintained at 70–75 F and 60–70 percent rh. Curl, film deformation, static, *etc.*, can cause considerable difficulty during this operation unless the proper conditions of temperature and humidity are maintained. Curl and film deformation affect the register and sharpness of the images produced and must be controlled to insure satisfactory prints. It is desirable to maintain the proper humidity to help prevent static marks on the film, as static electricity can easily be generated under this type of printing operation. The elimination of the static charge also helps keep the film clean, as a static charge usually attracts dirt and lint. Registration of the two films in black-and-white printing is aided by proper air conditioning, and it is even more necessary to provide for proper temperature and humidity in printing color motion pictures where two or three images, from as many separate films, must be superimposed in register onto one film.

STORAGE OF PROCESSED FILM

The storage of developed film differs from the storage of the raw stock. The material is no longer photosensitive, is seldom sealed against moisture, and much longer storage periods are generally involved. The conditions to be employed depend on: (1) the value of the records, (2) the length of storage time, and (3) whether they are on nitrate or safety base film.

Photographic film, like ordinary paper records, must be protected against fire, water, mold, and chemical or physical damage. In addition, photographic film must be protected against the extremes of relative humidity and heat which occur at some seasons or in some localities.

Relative humidity is much more important than temperature in the storage of processed film. High humidities damage gelatin, encourage the growth of mold, increase dimensional changes, accelerate the decomposition of nitrate support, and accelerate the deterioration of images in both black-and-white and color film. Low relative humidities result in a temporary increase in film curl and a decrease in flexibility, but this tendency is reversed when the humidity rises again. However, very low relative humidities should be avoided in film storage, because the film may crack or break if handled carelessly under these conditions.

Low temperatures are not harmful in film storage, and for some purposes are essential, provided that the film is allowed to warm up sufficiently before opening to avoid moisture condensation. However, high temperatures can be harmful since heat accelerates the decomposition of nitrate support and the fading of dye images in color film. Heat also accelerates film shrinkage and may produce physical distortions.

On the basis of required storage, photographic records can be broadly classified into those for commercial purposes and those for archival purposes.

Commercial records are those processed and stored to provide reasonable permanence. They include those photographic records made for temporary use only, and even those made for use in current files but which may be required for as long as 10 or 15 yr.

Archival records are those processed and stored to provide maximum permanence, perhaps hundreds of years. Actually, any pictures or records which cannot be replaced and which are likely to be of lasting interest should be included in this category. Historical records on microfilms, sheet films, or photographic papers are examples.

Commercial Storage of Safety Base Film

The room for commercial storage of safety base film should be protected from accidental water damage, whether by rain, flood, water pipes, or sewers. Air conditioning with carefully controlled relative humidity is always desirable for film storage, but it is not essential in the case of commercial storage in moderate climates. It is the extremes of relative humidity which are detrimental to film.

In a number of respects, the most satisfactory storage relative humidity for processed film is about 50 percent, although the range 25 to 60 percent is generally satisfactory for commercial storage. In regions where the relative humidity of the storage area exceeds 60 percent for any appreciable period of time, special precautions are required. Where complete air conditioning cannot be installed, the next choice is to install an electric refrigeration-type dehumidifier in a small room. The walls of the storage space should be vapor-sealed by coating them with asphalt paint, aluminum paint, or better, paper-laminated aluminum foil. A controlling humidistat should be installed and set at about 40 percent rh.

If the prevailing relative humidity is under 25 percent for long periods of time and trouble is encountered from curl or brittleness, controlled humidification is recommended.