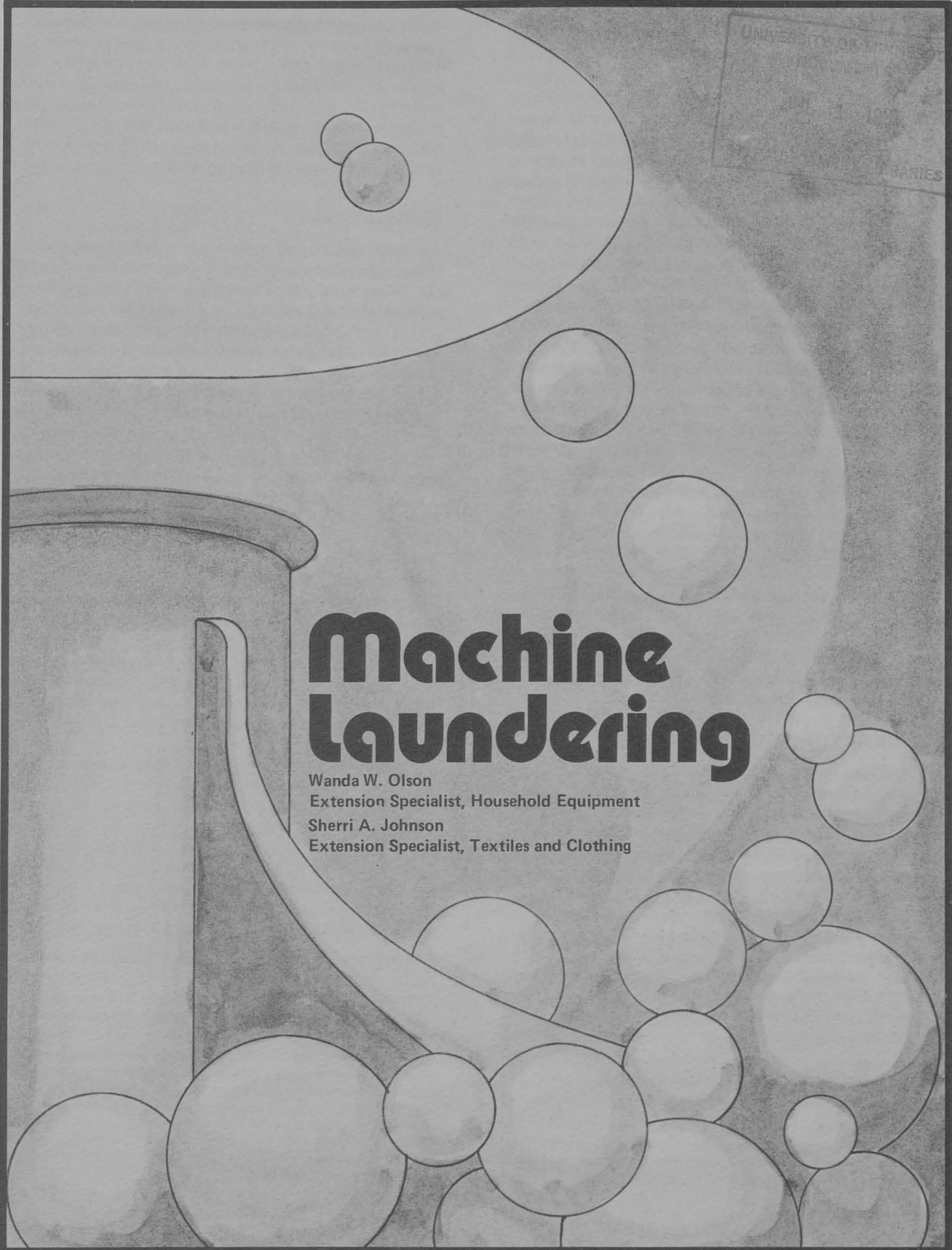


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# Machine Laundering

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How long people keep their clothing and household items depends upon care and normal wear, as well as change in fashion. This publication discusses methods for using energy efficiently and how to get your clothes and household items clean.

## ENERGY USE

Most of the energy used in clothes washing is for heating the water. One-fourth to one-half kWh is used to run the machine, and about 5 kWh of electricity or .30 CCF (hundred cubic feet) of gas are used to heat water for a laundry load using a hot wash/cold rinse.<sup>1</sup> The amount of energy can be reduced by reusing heated water or using lower temperature water. Heated water can be reused in an automatic clothes washer with the suds-saver or water-saver feature and in non-automatic clothes washers, such as wringers, and twin tub spinners. A warm wash/cold rinse uses half as much hot water as a hot wash/cold rinse because a warm setting is usually an equal mix of hot and cold water. The average temperature of cold water may be 50°-55° F. but can be 40° F. or lower in winter. If your water heater is set to deliver water at 130°-140° F. and your cold water is 50°-55° F., the warm setting on the washer will give you water in the warm range (90°-110° F.); however, if your water heater is set to deliver water at 110°-120° F., you would need to use the hot water setting on your clothes washer to get water in the warm range. A 10°-20° F. drop in temperature can be expected from heat loss to the pipes and to a cold washer. Using a cold rinse rather than a warm rinse will save about 2½ kWh of electricity, or 0.15 CCF of gas per load for water heating. Machine drying uses about 2½ kWh of electricity or 0.15 CCF of gas to dry a load of clothes.<sup>2</sup> If the clothes are rinsed in cold, rather than warm water, about 0.2 kWh more electricity will be used to machine dry the load;<sup>3</sup> even with additional drying time, a cold rinse should save about 2 kWh per load.

## WASHING CONDITIONS

Washing and drying directions usually are found on the care labels on new clothing and on household items such as towels and sheets. If the item is washable, it will indicate if it can be washed safely in hot, warm, or cold water, bleached, and machine dried. Additional washing instructions are included for items with some finishes, such as a garment with a flame retardant finish.

Some clothes washers automatically select water temperature and washing action for a specified type of load such as knits, towels or sturdy cottons, whites or colors. With most clothes washers, the user selects the water level,

water temperature, washing time, agitation, and spin speeds. The user also selects the type and amount of detergent. A combination of mechanical energy (agitation), chemical energy (detergent), and thermal energy (water temperature) is used in getting clothes clean. Reducing one type of energy, such as lowering water temperature, will require an increase in either the amount of detergent or other laundry products, or the increase of agitation speed or time. Factors affecting choice of water temperature, amount of detergent, and agitation speed are discussed separately.

## Hardness of Water

Soap cleans well only in soft or softened water. Detergents may be used in hard water, but they clean better in soft water. In very hard water, the use of a water softener product or a mechanical water softener may be needed.

One third of the Minnesota population served by municipal water systems has hard water of 15 grains per gallon (gpg) or more, (0-3.5 grains per gallon (gpg) is considered soft; 3.6-9 gpg, medium hard; 9.1-15 gpg, hard; over 15 gpg, very hard). Your city water department or city supervisor can tell you how hard your water is. If your water comes from a private well, you can have it analyzed for hardness by companies selling or servicing mechanical water softeners.

Phosphate-based water softener products such as Calgon, Spring Rain, Blue Rain Drops, and citrate-based products, such as Miracle White<sup>4</sup>, keep the hardness minerals in solution and eliminate some of the laundry problems caused by hard water. The softener product costs 10-15 cents per 1/2 cup (suggested amount on the package). More may be needed in very hard water or cold water. Less detergent is needed when you use a water softener product.

A mechanical water softener will remove water hardness minerals and eliminate laundry problems caused by hard water. You will use less detergent in softened water, but the mechanical water softener adds about 6-10 cents<sup>5</sup> for each laundry load.

Iron in water with a concentration as low as 0.2 ppm will cause stains. Methods to remove iron from the water are described in *Iron in Drinking Water*, Extension Folder M-154. Two forms of iron may be present. Ferrous iron (Fe<sup>+2</sup>) is generally a precipitate and has the recognized rusty color. Ferrous iron can be held in solution by a phosphate or citrate-based product, but ferric iron cannot. Compounds of ferric iron can sometimes be filtered out of water. Exposure to air or chlorine bleach converts ferrous iron to ferric.

<sup>1</sup> Assumes 18 gallons of water with a temperature rise of 90° F. with a water heater efficiency of 0.79 for electric and 0.48 for gas heaters.

<sup>2</sup> Federal Register, September 14, 1977.

<sup>3</sup> J. Schrage "Home Laundry: Appliance Systems for the 80s" Detergents in Depth proceedings from symposium sponsored by Soap and Detergent Association, April 10-11, 1980.

<sup>4</sup> Citrate is also non-precipitating, however, it is considered to be less effective than phosphate.

<sup>5</sup> Costs associated with a tank on exchange process and with ownership of the softener (including depreciation and the income the purchase price could have earned if invested) are based on 15 grains hardness, no iron content, a family of four using 60 gallons per person per day, 35 laundry loads per month. Costs of softening water for laundry are actually twice the total per gallon cost since only half of household water is used in ways which benefit from softening such as laundry, dishwashing and cleaning.

## Water Temperature

Hot, warm, or cold water can be used for cottons and linens. Acrylics, nylons, polyesters, triacetates, and washable rayons may also be washed in hot<sup>6</sup>, warm, or cold water. Do not use hot water for washable woolens, acetates, silks, and spandex.

Washing clothes in cold water is more effective with:

- normal or fast wash speed, full wash time (10-18 min)
- 1-1/2 to 2 times more detergent than used with hot water
- detergent completely dissolved in the water before clothes are added
- chlorine bleach — chlorine is effective in all temperatures of water; all fabric (oxygen) bleach is much more effective in water temperatures of 140°-160° F.
- items that are *not* greasy or heavily soiled, such as children's dirty clothes. (Use solvent on greasy items if they are to be washed in cold water. Soak heavily soiled items.)

Choosing water temperature depends upon fiber, as well as soil, need for disinfecting, shrinkage, and wrinkling.

**SOIL** — Hot water removes more soil, and there is less oily soil build-up<sup>7</sup> than with warm or cold water. Cold water prevents the "setting" of certain types of stains such as milk, eggs, blood, and other protein soils that can become permanent if washed in hot water; therefore, these stains must be pretreated before washing in hot water.

**DISINFECTANT** — Under normal circumstances, hot water with soap or detergent followed by machine or line drying provides adequate safety. Special efforts may be needed with an infectious illness. Hot water is more effective than warm or cold water in reducing bacteria in laundry items. Special products, such as liquid chlorine or quaternary compounds disinfect in any temperature water; phenolic compounds or pine oil products are not effective in cold water. Quaternary products are deactivated by soap or detergent and should be used only in the rinse water. Chlorine products, such as in any liquid chlorine bleach, and pine oil<sup>8</sup> products, such as Pine Sol and Al Pine, are available in grocery stores. Quaternary compounds<sup>9</sup>, such as Roccal Coop Sanitizer and phenolic compounds<sup>10</sup>, such as Fyne Pyne, and Fynetex are available with cleaning supplies in paint stores, farm, hardware, or industrial supply stores. Follow the manufacturer's instructions for use.

<sup>6</sup> These fibers are sensitive to the higher temperatures in machine drying and ironing.

<sup>7</sup> M. Morris and H.H. Prato, "Performance of Garments Related to Initial Cost and Care." *Home Economics Research Journal*, Vol. 7, No. 2, November 1978, pp. 80-81.

<sup>8</sup> Product should contain at least 70 percent pine oil to be used as a disinfectant.

<sup>9</sup> Label should state that the product contains benzalkonium chloride or quaternary ammonium compound such as alkyl dimethylbenzyl ammonium chloride.

<sup>10</sup> Label should state that the product contains ortho-benzyl-para-chlorophenol or ortho-phenyl-chlorophenol.

**SHRINKAGE** — Some fabrics may shrink when washed. In knits, this happens when yarns stretched during the knitting process relax and loop distortions are removed. The greater the loop distortion, the more shrinkage may occur. Some shrinkage may also occur due to fiber swelling and shrinkage, as in cotton, rayon, and acetate knits. Hot wash increases the rate of progressive shrinkage in such fibers, and therefore garment shrinkage is stabilized sooner in hot wash than in cold wash. Polyester and nylon knits, without a heat setting or shrink resistant treatment, will shrink more during machine drying than line drying because of the higher drying temperature.

Woolen fabrics can felt and shrink because of the unique characteristics of wool fibers. This felting shrinkage is usually eliminated today by the chemical treatment of fibers, such as with Wurlan. Without this treatment, felting shrinkage is never stabilized in the machine washing of woolen fabrics.

A shrink resistant treatment is found on some knitted and woven fabrics. This treatment is applied by chemical or mechanical means. To find out how much you can expect a garment or fabric to shrink, look on the garment label for the amount of "residual shrinkage" (2 percent shrinkage is considered acceptable in wovens and 5 percent in knits). Chart I gives an example of the effects of different rates of shrinkage.

**Chart I. Expected Shrinkage in Inches\* with Different Percentages of Residual Shrinkage on Denim Slacks: waist 34 inches, inseam 30 inches, outside length 40 inches.**

	Percentage Given on a Label					
	1	2	3	5	10	15
length	1/2"	3/4"	1-1/4"	2"	4"	6"
waist	1/4"	3/4"	1"	1-3/4"	3-1/2"	5"

\*Shrinkage rounded to the nearest 1/4 inch.

**WRINKLING** — Washable polyester or nylon knits and durable press fabrics wrinkle if they are hot or warm when going through the spinning cycle. Fabrics which are cooled before spinning will have fewer wrinkles. The cool down before spinning occurs automatically in a clothes washer with a permanent press cycle. At the end of the wash time, the wash water is drained from the tub, cold water fills, cools down the fabric, drains and spins.

## Length of Wash Time and Agitation Speed<sup>11</sup>

Use shorter wash periods and slower speeds if abrasion will cause pilling (as with acrylics and some polyesters and nylons) for felting or woolens. Use shorter wash periods and a slower speed for bonded, loosely knitted or woven fabrics, worn or fragile items.

**SOIL** — Longer wash periods and faster speeds will remove more soil, especially in cold water. A soak period can

<sup>11</sup> Some machines have only one speed.

be helpful if the wash period must be short and the agitation speed slower.

**AMOUNT OF WATER TO BE REMOVED** — Faster spinning removes more water. (Cotton, wool, and linen absorb more water than synthetics.) Faster spinning usually results in more wrinkling.

### Soap or Detergent

**AMOUNT** — The amount of detergent suggested on the box or bottle is usually based on a standard sized clothes washer, medium hard water, and average soil. Add more detergent for large clothes washers, hard water, if the clothes are very dirty, or cold water is used.

A standard-sized top loading clothes washer holds about 18 gallons at high fill; a front-loading clothes washer holds 9 gallons. The new, larger top-loading clothes washers, however, use about 22-25 gallons at high fill, while small semi-automatic portables use only 5-10 gallons per fill. If you have a sudsaver or wringer washing machine, you may need to add one-fourth to one-half of the original amount of detergent with each additional load. Use a low sudsing product in front-loading clothes washers, and low or high sudsing product in top-loading clothes washers.

**TYPES OF SOAPS AND DETERGENTS** — Laundry product packages often list ingredients used. The main ingredients of most detergents and soaps are the surfactants<sup>12</sup> and the builders. The surfactant loosens and removes soil and prevents it from depositing on the clothes. The builder serves as a water softener and prevents water hardness from reducing the cleaning effectiveness of the surfactant and provides proper alkalinity for cleaning. Builders may also react with oily soil and may emulsify oil. Detergents and soaps sold in Minnesota do not use phosphate as a builder.<sup>13</sup>

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<sup>12</sup> *The word surfactant comes from the words "surface active agent." Surfactants act to reduce surface tension of the water allowing it to penetrate fabrics and soil faster. The two types of surfactants in laundry detergents are anionic and nonionic. Detergents may use either or a combination of both.*

*Anionic — negatively charged, considered more effective for removing and suspending particulate soil but will attract positively charged water hardness ions and, therefore, may lose some efficiency; usually high sudsing.*

*Nonionic — considered more effective in oily soil than anionic surfactants, no attraction for water hardness ions, some are low sudsing.*

<sup>13</sup> *According to WPC-37 (Minnesota Pollution Agency Standard effective 2/1980) the maximum permissible concentration of phosphorous in products sold or distributed shall be:*

- (a) Laundry detergents and built soaps:  
0.5 percent phosphorus, by weight*
- (b) Machine dishwashing detergents:  
11.0 percent phosphorous, by weight*
- (c) All household cleaning agents except those listed in "a" and "b" intended for use in home:  
0.5 percent phosphorous, by weight*
- (d) Chemical water conditioners for machine laundry use:  
20.0 percent phosphorus, by weight.*

**LIQUID DETERGENTS** — The liquid detergents leave no deposit or precipitate on fabric; this is a critical factor when laundering flame retardant fabrics. Care labels on these fabrics often recommend the use of liquid detergents if nonphosphate laundry products are used. Flame retardant fabrics are found in sleepwear size 0 to 14. Some liquid detergents do not have a builder, others use citrate, a non-precipitating builder.

**GRANULAR DETERGENTS** — Phosphates, carbonates, silicates, citrates, and aluminosilicates are used as builders in granular detergent products. Carbonates soften water by reacting with water hardness minerals in a precipitate form; using aluminosilicates results in less precipitate. Many of the earlier nonphosphate detergents were high carbonate products and when used in hard water, resulted in an insoluble carbonate deposit on fabric and machines. Today's non-phosphate products generally use less carbonate, use silicates, or use a combination of both. The carbonate deposit is usually built up more slowly than with the higher carbonate products. Any granular buildup occurs gradually with many launderings; this results in a masking of color, an increase of fabric stiffness, and a harsh feel.<sup>14</sup> The rate of deposit depends upon the concentration of carbonate and the hardness of water. Because of this deposit, most flame retardant fabrics should not be washed with granular detergents, unless a phosphate-based water softener is added to the wash water *before* the detergent is added. Follow care instructions on garment or fabric. Some flame retardant fabrics, because of the fiber used (such as modacrylics), are not restrictive about the use of laundry products.

**SOAPS** — Soaps, such as Instant Fels, Ivory Snow, Ivory Flakes, or homemade soap are effective in soft water. In hard water, add a water softener to prevent the forming of curds which will leave a sticky deposit on clothes. It is essential to add the water softener to the first rinse water. Soaps are not recommended for laundering flame retardant fabrics.

### Other Laundry Aids

**WATER SOFTENERS**<sup>15</sup> — Softeners inactivate the hardness minerals reducing the efficiency of soap or detergent

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<sup>14</sup> *Research completed at Purdue University in 1975, M.S. Thesis, C. Schmidt, using low-carbonate-silicate built detergent showed that a carbonate buildup did occur gradually over a period of 30 launderings in water 10-12 grains hard. The manufacturers recommended amount of detergent for hard water was used.*

<sup>15</sup> *Precipitating water softeners usually contain sodium carbonate; nonprecipitating water softeners usually contain polyphosphate such as sodium hexametaphosphate or tripolyphosphate, citrate-based liquid products are available.*

and provide proper alkalinity for effective laundering. Water softeners are either precipitating or nonprecipitating. Washing soda is an example of a precipitating water softener, and when added to hard water, small insoluble particles (precipitate) are formed. When a nonprecipitating water conditioner, such as Calgon, Spring Rain or Blue Raindrops, is added to the hard water, the solution remains clear. Add these products to the wash water before the detergent.

**BLEACHES<sup>16</sup>** — Bleaches are effective in removing colored stains; they also change the chemical structure of some soils, making them easier to remove.

There are two main types of bleaches: chlorine, which is usually liquid, and oxygen which is usually powdered. The oxygen bleach can be safely used on any fiber; the chlorine can be used on all common fibers except spandex, silk, and wool. Labels on items usually indicate whether bleaching is advised. Colored fabrics may be tested for bleach fastness by following the procedures:

Chlorine bleach (such as Chlorox and Purex)	Apply 1 drop of a bleach solution, made by adding 1 tablespoon bleach to 1/4 cup water, to an inconspicuous portion of the fabric; be sure it penetrates the fabric. After one minute check for color change.
Oxygen bleach (such as Snowy, Dexol, Chlorox II)	Dip an unexposed part of the item up and down in a solution of 1 tablespoon bleach to 1/2 gallon of <i>hot</i> water (140° F. or above). Check for bleeding or color change.

Liquid chlorine bleaches are effective in removing stains, disinfecting, and deodorizing in any water temperature or hardness. To prevent fabric damage, dilute chlorine bleach (1 cup to 1 quart water), before adding to the wash. Bleaching action takes only two to four minutes. Chlorine bleach is usually added at the end of the wash period because chlorine will reduce the benefits from brightening agents and enzymes which may be in the detergent. Liquid chlorine bleach should not be used when water contains iron because it may cause yellow staining.

In hot water oxygen bleaches are most effective in removing stains; bleaching action requires more time than with chlorine bleach. Oxygen bleaches available to consumers are not effective sanitizers.

**SOLVENT-BASED PRETREATMENT PRODUCTS<sup>17</sup>**  
— Pretreatment products, such as Spray & Wash or Shout, are

effective on oil-based stains. These products contain a grease solvent which helps to penetrate the surface of the soil.

Grease solvents work very quickly; the treated items should be added to the wash water before the solvent evaporates. Use solvent products with any temperature water or any type of detergent or bleach.

**ENZYME PRESOAK** — Products, such as Axion and Biz, are effective in removing protein-based stains such as blood, fruit juices, and felt tip ink. They are *not* effective in removing oil-based stains. Enzyme products require time to work. For best results, soak in warm water for at least one-half hour; effectiveness is reduced in cold water or at temperatures above 140° F. The products can be safely used on all fibers (except silk and wool), with all detergents, and with oxygen bleaches, such as Snowy and Dexol. Chlorine bleach destroys the enzyme action and should not be used with enzyme products, unless the bleach is added after the enzyme action is completed.

**FABRIC SOFTENERS<sup>18</sup>** — All fabric softeners leave a residue on the fabric that softens the fabric, increases fabric bulk, and reduces static cling.

Fabric softener products are either wash cycle added, such as Rain Barrel; rinse cycle added, such as Downy, Sta-Puf, and Final Touch; or dryer added. The dryer added softeners are available in a sheet, fabric or foam form, such as Bounce, Cling Free, or a pad form attached to the plastic dryer baffle, such as Free 'n Soft. The sheet form is added with each load of clothes and may be used for two or three loads. The solid is semi-permanently attached to the dryer, and it is slowly absorbed by the fabric surfaces as the clothes come into contact with the pad. One pad should last for 40-50 dryer loads.

Liquid fabric softener, poured directly onto the fabric, may leave an oily stain. To remove the stain, dampen the fabric, rub the spot with a bar of soap, and rewash the garment.

## GENERAL LAUNDRY PROCEDURES

All laundry, especially *heavily soiled* and *white items* require good laundry practices:

— sort laundry into loads that require the same water temperature, agitation speed, and use of bleach. *Do not* wash in the same load:

- whites and dark colors (nylon is a “scavenger” fiber; white nylon items should only be washed with other white items)
- very dirty and lightly soiled items
- items that attract lint and those that produce lint (for example: synthetic socks and pants and some fabrics, such as corduroy, can pick up lint when washed with bath towels and fabrics such as velour and chenille; lint shows up more on dark colors; dark lint causes the greater problem on white or light colored fabrics.

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<sup>16</sup> The active ingredient in liquid chlorine bleach is sodium hypochlorite. The main ingredient in powdered oxygen bleach is sodium perborate tetrahydrate; oxygen bleaches may also contain water softeners, brighteners, surfactants, and bluing agents.

<sup>17</sup> Usually contains a nonionic surfactant and a solvent (alcohol, glycol ether, petroleum distillate, or chlorinated hydrocarbons).

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<sup>18</sup> Products are based on long chain fatty molecules, usually cationic surfactants which attach to the fabric.

– if you are washing garments with a flame retardant finish, such as children's nightwear, follow label instructions carefully. Typical directions include:

- use soft water, if possible
- use a heavy-duty liquid laundry detergent; *do not* use the detergent that includes fabric softener; follow directions on the container
- do not use bleach
- do not use fabric softener
- do not use soap or soap powder
- do not use hot water

Pretreat spots and stains; soak very dirty items and determine need for bleaching. Wash items before they get too dirty or *soak or rinse* items, using a laundry detergent or a presoak product or rub soiled area with soap or liquid detergent, before adding to the wash. If laundry products, rather than plain water, are used for soaking, they help prevent soil from redepositing on the items.

Use the hot water setting on your clothes washer for heavily soiled or white items, except for washable woolens, acetate, silk, and spandex. The water in your clothes washer should be at least 120°F. Hot water sets some stains; soak items with perspiration, blood, or protein food stains in cool water before washing in hot water.

If a precipitating water softener is used, add and dissolve before adding a detergent.

Dissolve granular detergent in 1 quart of hot water before adding to clothes washer. This is especially important when washing in cool water and/or with the short wash cycles.

Use more detergent than recommended if water is hard (unless you use a water softener product), if washing in cold water, or if using a gentle cycle. Extra detergent will help remove additional soil, especially oily soil if washing white fabrics of synthetic fibers, such as polyester and nylon, or fabrics with a crease-resistant finish. More detergent is needed to prevent the soil in the water from redepositing on fabrics with synthetic fiber or those with a crease-resistant finish than with untreated cottons.

If you are using a suds-saver or non-automatic clothes washer:

- wash lightly soiled items first
- use chlorine bleach only if the following loads can be bleached
- for wringer washers, if more than one load will be rinsed in the same water, sort so that loads attracting lint will not be *rinsed* after those producing lint

## SPECIAL PROBLEMS

**TO REMOVE GREYNESS CAUSED BY SOIL LEFT IN CLOTHES** – Keeping whites “white” is dependent more on using enough detergent than on any other single factor in machine laundering. For extreme soil problems, follow this procedure:

- (1) Place in clothes washer basket 1 to 2 cups phosphate-based water softener, such as Calgon or Spring Rain,

more if water is very hard; add 1/4 to 1/2 cup liquid detergent or 1-1/2 to 2 cups detergent (soap if water is soft)

(2) Put in clothes

- (3) Set controls for hot wash and start wash cycle fill. Add 1/2 cup liquid chlorine bleach, such as Clorox, Hilex, or Purex, diluted in 1 quart of water. Agitate and complete cycle.

**TO REMOVE STAINS** – Most laundry loads include stained items; often these are greasy stains or ground-in dirt. Many stains are more difficult to remove from fabrics with a durable press finish or polyester/cotton blends, than 100 percent polyester or 100 percent cotton. Oil-based stains, such as butter or margarine, cooking oil, chocolate, or auto oil, are difficult to remove from polyester fabrics; with age, oil stains and protein stains, such as blood and baby formula, become more difficult to remove.

Soaking or pretreating is common. Products usually used are enzyme presoaks, liquid bleach, powdered or liquid detergent, and solvent pretreatment products. Fresh stains are easier to remove than old stains. Water alone will remove some stains like salt, sugar, tea, and coffee; water alone will *not* remove oily soils. Cold water followed by the use of enzyme products will help to remove protein stains. Using a laundry aid when soaking will help water penetrate the soil, and any soil removed will be held in the water and not deposited back on the fabric. The laundry aids will help prevent rusting of automatic washer parts.

Use grease solvents to remove oil stains. Grease solvents are found in prewash products, such as Spray & Wash, Shout, Spray-Away, and such household cleaners as Lestoil, and are the major ingredient in such spot removal products as Carbona. Full strength liquid detergents are also effective in removing oily stains; a paste of granular detergent can be used, however, it is not as effective and requires more time to act than liquid detergents.

Aerosol prewash products containing tetrachloroethylene should be used with care. Don't spray near appliances with a baked on finish or near plastic part surfaces, because the product may damage these surfaces. The product may damage some buttons.

Solvents may remove oily stains, but they also add to the soil load, and in some cases, additional detergent is needed.

Enzyme products are not effective in removing oily stains, however, they are effective on protein stains.

Iron stains can be removed by soaking the item in a solution of oxalic acid (4 teaspoons per gallon). Oxalic acid is a poison and should be used with care; it can be purchased at a drug store by adults. If large or several items are stained, a commercial rust remover that will not damage a clothes washer, such as Rover, may be used. Follow directions on the container.

For further information on removing spots and stains, refer to Extension Bulletin 423, *Quick n' Easy Stain Removal*.

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