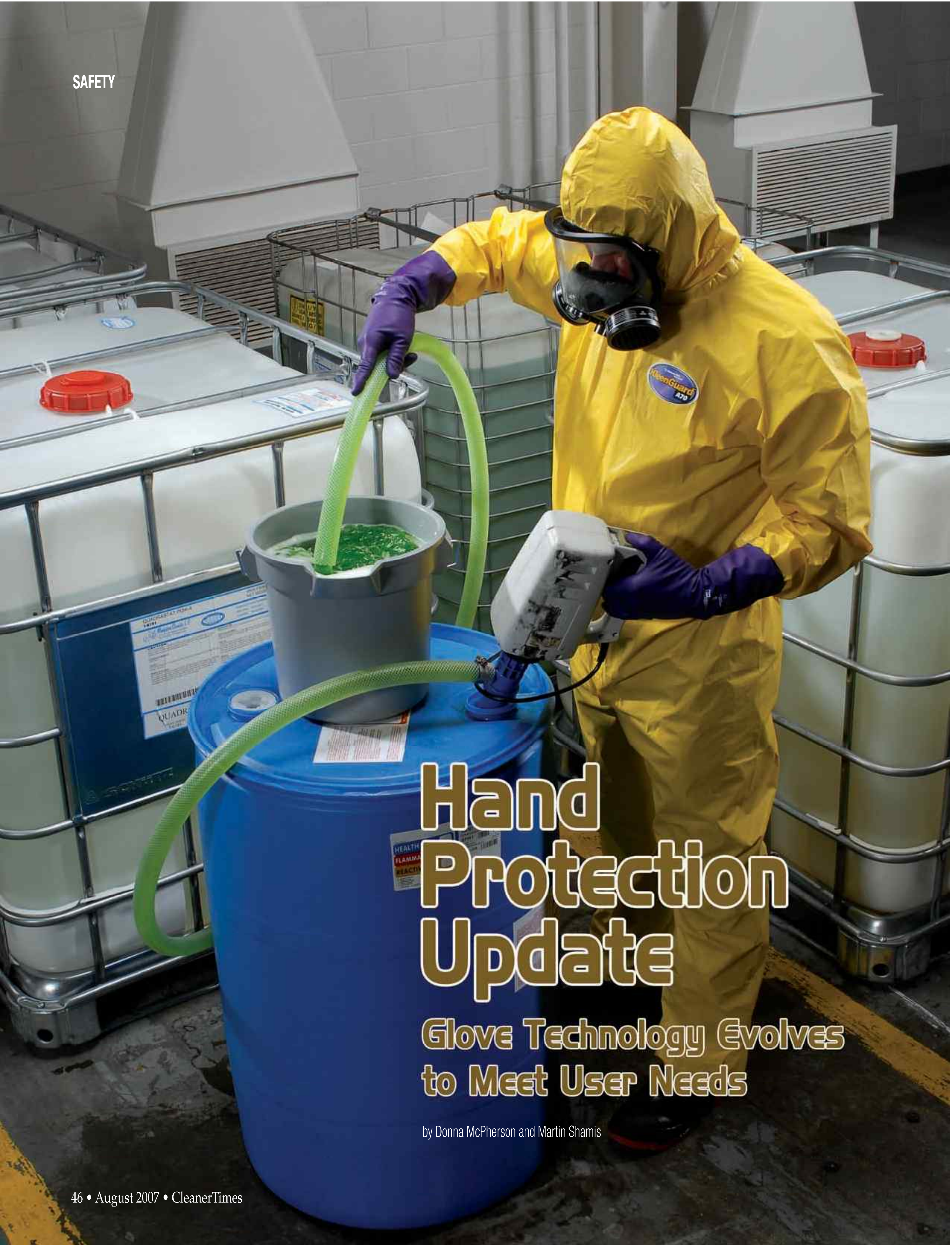

Hand Protection Update

Glove Technology Evolves to Meet User Needs

by Donna McPherson and Martin Shamis

If you are a pressure washer mechanic or a cleaning contractor, you work with your hands and chances are you or someone you work with has experienced a hand injury. In fact, about one million U.S. workers a year receive emergency department treatment for acute hand injuries, which range from cuts, blisters, and abrasions to lacerations, burns, punctures, and fractures.

Hand injuries take a financial toll in addition to the physical pain. The average hand injury claim has now exceeded $6000, with each lost-time worker's compensation claim reaching nearly $7500, according to the Bureau of Labor Statistics (BLS) and the National Safety Council. The overall drain on employee productivity becomes apparent, especially considering that the BLS estimates there are about 110,000 estimated lost-time hand injuries every year.

A study conducted by the Liberty Mutual Research Institute for Safety found that glove use significantly reduced hand injury—by 60 percent. And, fortunately, for workers who need hand protection, glove technology has evolved over the years to the point where today many choices for hand protection can be matched to specific worker tasks and applications.

A Brief History

Like other forms of personal protective equipment (PPE), such as eye and hearing protection, industrial hand protection products were initially intended to simply protect the worker. Later, focus shifted to worker comfort, then to functionality and performance, and finally to style.

In the first half of the Twentieth century, the only hand protection products available were basic cotton or leather work gloves that offered minimal protection from cuts and hazardous substances. Fit and function were an afterthought, at best. Glove industry historians note that early glove innovations sought to improve resistance to cuts and abrasions as well as oils and chemicals while increasing comfort and wearability.

The result was the development of coated-cotton gloves using natural rubber, Neoprene (the first commercial synthetic rubber) and other synthetics. Most glove coating technology at this time was manual, though automated dipping technology was introduced in the 1940s, which helped glove suppliers boost capacity to meet increasing demands of the nation's growing workforce.

By mid-century, advances in glove styles and compound dipping were complemented by production innovations designed to improve cost and quality. In addition to improvements in cut resistance, this era also saw the development of coated gloves with textured finishes to meet grip requirements.

In the mid-1970s, the formation of the Occupational Safety and Health Administration (OSHA) led to an increased focus on worker safety products. Available technologies were keeping pace. PVC-impregnated cotton gloves were quickly followed by nitrile-laminated fabrics for better fit, comfort, and protection.

Nitrile-related technology continued in the 1980s, with the increased use of palm coating for industrial applications as well as use in unsupported gloves. (A supported glove has a knit or woven lining that is dipped. An unsupported glove does not have a knit or woven lining, but may have cotton or synthetic fiber "flocking" inside.) This development improved comfort and durability as well as cut and chemical resistance and helped meet the burgeoning high-tech industry's need for protecting products and processes from contamination by workers in addition to protecting workers themselves.

Knitted gloves with engineered fibers also became popular in the 1980s and allowed for reduced weight, increased flexibility, and better resistance to cuts and abrasions. This development was followed in the 1990s by natural rubber flat dip technology, which began to replace the use of leather gloves. Seamless designs—first introduced in the 1970s—proliferated in the 1980s as users were drawn to the comfort and dexterity advantages.

Today, the industrial glove industry is seeing the use of more high-performance synthetic materials, along with engineered, high-performance yarns made of ultra-high molecular weight polyethylene and aramid fibers, which offer strength properties for cut resistance. Some manufacturers are even using stainless steel.

Chemical- and Liquid-Resistant Gloves

Chemical-resistant gloves are made with different kinds of rubber: natural, butyl, neoprene, nitrile and fluorocarbon; or various kinds of plastic: polyvinyl chloride (PVC), polyvinyl alcohol and polyethylene. These materials can be blended or laminated for better performance. As a general rule, the thicker the glove material, the greater the chemical resistance, but thick gloves may impair grip and dexterity, having a negative impact on safety. Some examples of chemical-resistant gloves include:

Butyl gloves are made of a synthetic rubber and protect against a wide variety of chemical, such as peroxide, rocket fuels, highly corrosive acids (nitric acid, sulfuric acid, hydrofluoric acid and red-fuming nitric acid), strong bases, alcohols, aldehydes, ketones, esters and nitrocompounds. Butyl gloves also resist oxidation, ozone corrosion and abrasion, and remain flexible at low temperatures. Butyl rubber does not perform well with aliphatic and aromatic hydrocarbons and halogenated solvents.

Natural (latex) rubber gloves are comfortable to wear, which makes them a popular general-purpose glove. They feature outstanding tensile strength, elasticity and temperature resistance. In addition to resisting abrasions caused by grinding and polishing, these gloves protect workers' hands from most water solutions of acids, alkalis, salts and ketones. Latex gloves have caused allergic reactions in some individuals and may not be appropriate for all employees. Hypoallergenic gloves, glove liners and powderless gloves are possible alternatives for workers who are allergic to latex gloves.

Neoprene gloves are made of synthetic rubber and offer good pliability, finger dexterity, high density and tear resistance. They protect against hydraulic fluids, gasoline, alcohols, organic acids and alkalis. They generally have chemical and wear resistance properties superior to those made of natural rubber.

Nitrile gloves are made of a copolymer and provide protection from chlorinated solvents such as trichloroethylene and perchloroethylene. Although intended for jobs requiring dexterity and sensitivity, nitrile gloves stand up to heavy use even after prolonged exposure to substances that cause other gloves to deteriorate. They offer protection when working with oils, greases, acids, caustics, and alcohols, but are generally not recommended for use with strong oxidizing agents, aromatic solvents, ketones, and acetates.

Source: OSHA

The first thin-gauge gloves were made of natural rubber latex and were developed primarily to protect healthcare professionals and patients from the spread of germs. However, user sensitivity to the proteins found in latex prompted the industry to find alternatives in materials such as vinyl, nitrile, and neoprene.

Latex raw material pricing has also become a big issue in recent years. Supply and demand economics have driven latex prices up by 80 percent since January 2005, partly in response to world demand for natural rubber in a variety of applications and industries as well as reduced rubber yields due to bad weather and conversion of rubber plantations into new crops.

Although natural rubber latex remains the most common material for both unsupported and supported gloves, nitrile gloves have become especially attractive compared with latex gloves due to their cost, cleanliness, comfort, and consistency attributes. They also provide advantages compared with vinyl gloves. In fact, vinyl gloves are banned in parts of the world and in certain use areas and have a relatively high failure rate.

Standards and Regulations Development

Concurrent with the advent of new glove technologies in the 1970s and beyond was the development and subsequent refinement of industry standards and regulations relating to gloves and other personal protective equipment. OSHA's Hand Protection Standard, 29 CFR 1910.138 requires that "employers shall select and require employees to use appropriate hand protection [and that] employers shall base the selection of the appropriate hand protection on an evaluation of the performance characteristics of the hand protection relative to the task(s) to be performed, conditions present, duration of use, and the hazards and potential hazards identified."

The American Society for Testing and Materials (ASTM) originally published its *ASTM F739-99a Standard Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids or Gases under Conditions of Continuous Contact* in 1981, followed by *ASTM F 1383-96 Standard Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids or Gases under Conditions of Intermittent Contact*.

The International Safety Equipment Association also has a glove standard: *ANSI/ISEA 105-2005, American National Standard for Hand Protection Selection Criteria*, which provides a consistent, numeric-scale method for manufacturers to rate their products against certain contaminants and exposures including puncture and abrasion resistance, chemical permeation and degradation, detection of holes, and heat and flame resistance. New to the 2005 edition of the standard are tests and selection criteria for vibration reduction and dexterity.

While industrial glove standards in the United States are voluntary, in Europe, they are law. All gloves sold in European Community countries must comply with the 1992 Personal Protective Equipment Directive for the European Community and carry the CE mark.

One of the key issues with industrial glove standards that has yet to be addressed is glove nomenclature; users don't always understand, for example, that a "cut-resistant" glove is not "cut-proof" or that the glove may resist certain types or levels of cuts but not others.

Today's Advances

Today, new technologies in the industrial glove industry as a whole face a bit of an investment slump. The main problems are globalization and commoditization, as offshore imports (primarily from China and other Asian nations) tend to drive down prices (to grab market share). In developed countries, however, investment in glove R&D is more aggressive, even going back in the supply chain to raw material suppliers.

Because industrial glove materials have become so advanced, most development of new glove technologies today tends to focus on issues of fit, function, and style. Proper fit is important because it translates to improved productivity; if the glove is more comfortable to wear, users are more likely to comply with wearing protocols. Fit issues include finger length (not too long so that the glove might get caught in moving equipment) and overall sizing, (hand circumference not too small that it reduces the user's range of motion) as well as task-specific fit attributes such as including ventilated backs on general purpose work gloves. The important take-away here is that proper protection does not have to be uncomfortable.

Glove comfort also extends to the effect of gloves on the user's skin. Many unsupported gloves, for example, are flock-lined on the inside—coated with cotton or synthetic fibers—to improve extended wearing comfort. In addition, cotton linings provide good absorption of perspiration and good hand comfort compared to rayon and synthetic fibers.

One of the emerging comfort issues industrial glove manufacturers are seeking to solve—in addition to latex-related allergies—is dry skin. Gloves that contain emollients inside to help keep hands moisturized and soft are under investigation.

Function refers to the performance of the glove: Does the glove provide protection from the specific hazards found in the work setting? This can refer to chemical resistance, abrasion resistance, cut resistance, puncture resistance, dexterity, and contamination control. Recent events including 9/11 and Hurricane Katrina have prompted the industry to think about how to combine different functionalities into a single glove, for example, a glove that provides cut/puncture resistance and dexterity, along with protection against germs for post-hurricane clean-up activities.

Finally, style is becoming increasingly important among wearers—especially with the emergence of the Generation-Y workforce. In fact, gloves and eyewear tend to be ahead of most other PPE in terms of style; and anecdotal evidence suggests that style and comfort do indeed improve compliance with wearing protocols. Leading glove suppliers are taking cues from the retail clothing and performance athletic clothing markets to develop trendy, yet functional styles that people want to wear.

Vinyl, Nitrile, or Latex?

Nitrile	Latex	Vinyl
Inherently static dissipative; appropriate for ESD-sensitive applications	Inherently insulative; not appropriate for ESD-sensitive applications	Static dissipative; appropriate for applications without cleanliness requirements
Consistent in composition and cleanliness	Composition varies day-to-day and from season-to-season	Consistent in composition, but cleanliness varies from supplier to supplier and grade to grade
Durable and stands up to rigorous cleaning	Not as durable as nitrile	Poor durability; breaks down in use
Excellent chemical protection over range of chemicals; good performance with solvents	Limited protection over range of chemicals	Limited chemical protection
Not significantly affected by UV light or heat	Easily degraded by UV light and heat without the proper additive	Not affected by UV light
Lower elastic memory; retains approx 50 percent of stretch force for extra comfort during long wearing periods	High elastic memory; retains 85 percent of stretch force over a short time period causing user hand fatigue	Not elastic
Synthetic product with no natural latex proteins	Natural rubber latex protein allergens increase risk of Type 1 hypersentivity	Synthetic product with no natural rubber latex proteins
Quickly approaching feel (comfort) advantages of latex	Traditionally offers a comfortable feel	Baggy/clumsy fit

Conclusion

In the face of increased globalization and commoditization of the glove market, leading suppliers of hand protection products are differentiating their offerings with continued innovation driven by market research and testing and supported by training at all levels of the supply and user chain. The most successful glove suppliers also are finding ways to bundle other PPE with gloves, for head-to-toe protection that can't be matched by low-cost, offshore suppliers.

As we move through the early part of the Twenty-first century, those glove users not content with purchasing a me-too product will be able to take advantage of gloves with detailed performance specifications and consumer-driven styles designed to match individual user needs with the right glove for the job.

*Donna McPherson is Senior Category Manager, Kleenguard Brand Products, and Martin Shamis is a Senior Research Scientist at Kimberly-Clark Professional (**www.kcprofessional.com**), Roswell, GA.* CT