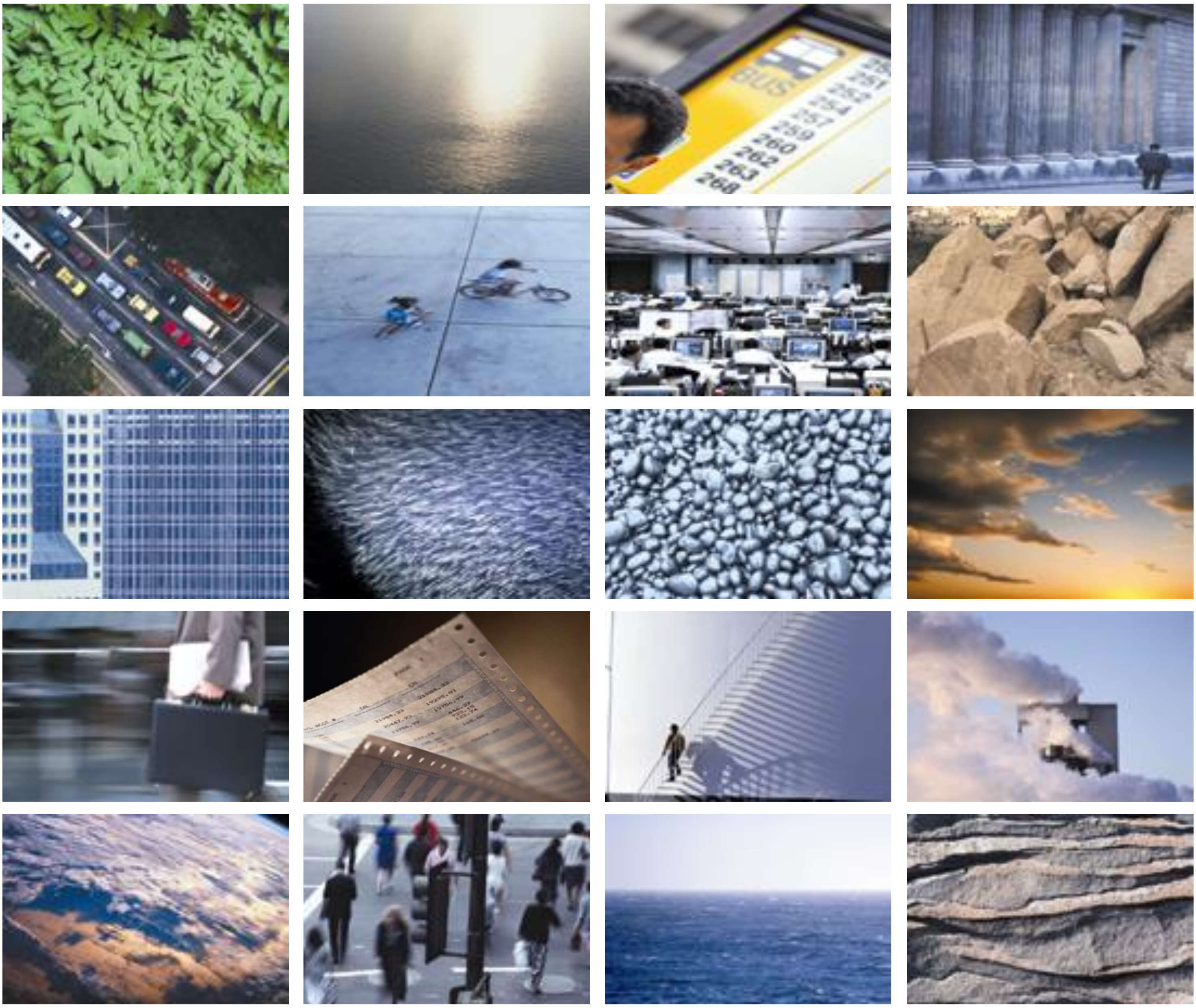

Environmental Performance of Plumbing Pipe Materials

Briefing document

November 2015

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Prepared by:

Michael Collins & Saori Smith

For and on behalf of
Environmental Resources Management

Approved by: Simon Aumonier
Signed:

Position: Partner

Date: 23 November 2015

Introduction

Already known for its easy installation and long-term reliability, Lubrizol Advanced Materials Inc. has conducted a life cycle assessment (LCA) to better understand the environmental impacts of FlowGuard® pipe and fittings.

FlowGuard® products are made from an engineered polymer known chemically as chlorinated polyvinylchloride (CPVC), which offers reliability and simplified installation using readily available, inexpensive tools.

Although plastic pipes have been in use since the 1950s, traditionally, water distribution pipes in buildings have been constructed of copper. The change in copper price over the last 20 years has meant that pipes made from FlowGuard® CPVC have gained in popularity.

FlowGuard® pipes and fittings are manufactured from specially formulated CPVC, produced by Lubrizol Advanced Materials, and are used for hot and cold water distribution (HCWD) systems. FlowGuard® pipes and fittings have been installed in a wide array of residential and commercial applications.

FlowGuard® pipes and fittings offer a number of advantageous characteristics. They are more practical to install than metal pipes, as the material is less expensive and the installation process is less labor-intensive. Unlike copper, CPVC has no significant scrap value away from the construction site and therefore it is less of a target for theft. Copper theft is a serious problem in the United States, with the National Insurance Crime Bureau recently reporting that of the 39,993 total metal theft claims in 2014, 38,985 (98%) were related to copper (1).

From a performance standpoint, FlowGuard® CPVC systems are highly resistant to pitting, corrosion and scale, which means avoidance of pinhole leaks, leaching and no scale build up to hinder water flow over time (2). Along with other plastic pipes, they transmit less noise in service than metal pipes (3) (ie noise transport caused by water 'hammer', flow speed and thermal expansion) and are less prone to condensation. FlowGuard® CPVC systems are also lighter weight than copper systems (see *Table 2* below), meaning that less material is required for their manufacture, resulting in reduced materials handling and transport costs.

(1) Kudla J, Metal Theft Claims and Questionable Claim Referrals from January 1, 2012 through December 31, 2014. National Insurance Crime Bureau. July 15, 2015
(2) Lubrizol, More inside™ :FlowGuard Gold® pipe & fittings deliver dependability and durability copper can't, 2013
(3) http://www.teppfa.eu/faq-test.html?catid=1 (For more information, please refer to the publication of 'Installateur' (Technical Magazine in The Netherlands) HM: date 2009)

In addition to the differences in transport, there are also different environmental burdens in production, as copper pipes are produced by the metals sector and require mining and smelting operations, whereas polymer production for plastic pipes is associated with the petrochemical sector and requires natural gas and crude oil extraction and refinery operations.

The peer-reviewed LCA of FlowGuard® pipes was conducted by Environmental Resources Management Limited (ERM) in accordance with the international standard for LCA, ISO 14040/44. This briefing note presents results extracted from the FlowGuard® LCA, which have been analyzed alongside the results from other environmental studies of copper tube in the public domain.

About LCA

A life cycle assessment or LCA is an internationally recognized technique used to understand the environmental impacts of a product by measuring all material and energy inputs and outputs throughout the product's life cycle. While many studies currently focus on only carbon, an LCA approach goes further to include a variety of environmental impact categories such as resource depletion, acidification and eutrophication.

LCA is endorsed by the US EPA and has been used to influence policy making by the California Air Resources Board (CARB) and California Department of Resources Recycling and Recovery.

FlowGuard® LCA

The FlowGuard® LCA, completed in 2015, considered the CPVC piping system in its function for hot and cold water distribution, including both pipe and fittings. The study is considered "cradle-to-grave", which means that all life cycle stages from raw material extraction through to processing and blending, to distribution, use and management at end of life have been included. The quality of data used is very good. Primary data were obtained for the production of the FlowGuard® compound and the manufacture of FlowGuard® pipes and reflect pipe manufacture in 2014.

Copper

An LCA of copper products published by the European Copper Institute [1] provides a peer reviewed environmental impact assessment of copper products, including copper tube. The copper tube assessed has a specification of 15mm diameter and 1mm wall thickness, which is equivalent to a ½ inch diameter. The copper tube product assessed has greater than 50% scrap content. LCA results are presented for a baseline year, 2000, and reflect data published from 1992 to 2001.

(1) Deutsches Kupferinstitut (2005), 'LCA of Copper Products', for the European Copper Institute

Cradle to Gate LCA Results

The cradle-to-gate results of the FlowGuard® LCA are presented in *Table 1* alongside LCA results from publically available LCAs for copper tube. The results have been normalized and are presented per 1000 feet of pipe. Lubrizol's FlowGuard® LCA appraises a range of pipe sizes and wall thicknesses. SDR-11, with a 0.5 inch diameter, is presented in this briefing note as it is considered the equivalent of the copper tube specification presented in *Table 2*.

Cradle to gate results for the production of pipe have been presented as this reflects a common point in the value chain for which the different LCAs provide results. As a result, fittings and other installation materials, use and disposal are not included.

The studies differ in scope and age, but have been presented together to aid discussion of the benefits of LCA as an approach better to understand product environmental impacts.

The results suggest that for the impacts presented the contributions are of a similar order of magnitude for both materials. The global warming potential – or carbon footprint – for 1000ft of FlowGuard® CPVC and copper tube can be considered equivalent to that of driving 390 miles (1) and 670 miles, respectively. Considering the age of the public studies and their differing scopes, it is not possible to draw conclusions with regard to environmental preference. Also, it should be noted that different materials may require different pipe lengths to deliver water within the same building, with varying emphasis on fittings, joining materials and energy consumption. However, if the production processes and the weight difference are considered, it is suggested that copper system would incur a greater impact even without considering the additional impacts of the fixtures and fittings.

To truly compare the products it is necessary for a full Life Cycle Assessment to be completed to the international standard. Such an LCA would require equivalent functionality for a specific geography and application to be appraised. The same system boundaries including consistent data requirements and impact assessment methods would be required. This type of assessment is typically achieved through the development of specific Product Category Rules such as those developed by the ASTM Environmental Product Declaration scheme (2).

(1) Assuming an emission factor for a passenger vehicle of 0.37 $kgCO_{2eq}$/vehicle mile. Source United States Environmental Protection Agency Emission Factors Hub (April 2014)

(2) http://www.astm.org/CERTIFICATION/filtrexx40.cgi?-P+PROG+7+cert_detail.frm

Table 1 ***Environmental LCA results per 1000 ft of pipe (cradle to gate)***

	Global Warming Potential *kg CO_2eq*	Acidification *kg SO_2eq*	Eutrophication *kg PO_4eq*	Ozone depletion potential *kg CFC-11-eq*	Photochemical oxidation *kg C_2H_4eq*
FlowGuard®	145.1	0.796	0.229	1.37E-05	0.034
Copper	248.7	1.524	0.549	3.96E-05	0.110

Table 2 ***Pipe specifications used to normalize results from the studies***

Pipe Material	Specification	Weight kg per m	Weight lb per ft	Source
FlowGuard®	SDR-11 0.5 inch diameter	0.123	0.083	Lubrizol Advanced Materials Inc.
Copper	Type L 0.5 inch diameter	0.390	0.262	European Copper Institute

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ERM's Manchester Office

11th Floor
5 Exchange Quay
Manchester M5 3EF
T: +44 161 958 8853
F: +44 161 958 8888

www.erm.com