EC ENVIRONMENT DIRECTORATE

WATER, MARINE AND SOIL UNIT

EUTROPHICATION OF WATERS, ROLE OF PHOSPHATES,PREVENTIVE MEASURES

PHOSPHATES AND ALTERNATIVE DETERGENT BUILDERS –

WRC SYNTHESIS-06 2002-

SUMMARY

Introduction

Recognition of the relationship between increasing phosphorus inputs to surface waters and the subsequent increase in eutrophication of water bodies gave rise to public concern during the 1970's and 1980's. This led to action by several countries including the USA, Japan and some EU member states, to reduce phosphorus loads, particularly from urban and industrial point sources.

The two main areas of action that have taken place, particularly in the late 1980's and early 1990's are:

- A reduction in the amount of sodium tripolyphosphate (STPP) used in detergent builders and switch to 'alternative' non-phosphate based builders, such as Zeolite A; and,
- Improving wastewater treatment through implementation of the Urban Wastewater Treatment Directive (UWWTD).

Where STPP is used as builder in household detergents it contributes to up to 50% of soluble (bioavailable) phosphorus in municipal wastewater, therefore a reduction in the use of phosphate based detergents should have a positive impact on the eutrophication of surface water bodies. Measures to reduce the use of STPP based detergents in the EU included the introduction of laws or voluntary agreements to change to Zeolite A as the builder for household laundry detergents. As a result STPP consumption has decreased substantially since the early 1980's, with dramatic decreases observed in Germany, Italy, the Netherlands and Switzerland. The widespread introduction of zeolite based detergents, even in countries where no formal action was taken, implies widespread acceptance of zeolite based detergents throughout Member States.

The European Commission (EC) has implemented this study to address the current use of phosphates in detergents throughout the European Union (EU) and recommend appropriate measures to improve the current situation. The study covers the fifteen Member States of the EU and the three accession countries Poland, Hungary and the Czech Republic.

The aim of the study is to investigate the costs and benefits of substituting phosphorus in detergents with other appropriate builders and to provide recommendations on the most appropriate method of reducing phosphorus concentrations in surface waters, through either improving wastewater treatment, banning the use of phosphates as detergent builders, or a combination of the two approaches.

With the exceptions of Belgium and the Irish republic, measures to move from the use of STPP to Zeolite A in domestic laundry detergents in EU member states were initiated by 1990. Most measures were either statutory limits on the STPP content, or voluntary agreements with detergent suppliers.

As a result of these measures STPP consumption decreased dramatically between 1984 and 1990 in Germany, Italy, the Netherlands and Switzerland, and is now effectively zero in these countries. In all these countries, voluntary or legislative action was taken during the same period. STPP consumption decreased more gradually between 1984 and 1990 in Austria, Belgium, Denmark, Finland, Ireland and Sweden, although is now low or zero. In other EU

member states, household laundry detergents built from STPP and from Zeolite A have roughly equal market shares, including France, Greece, Portugal, Spain, UK. The same applies in the Czech Republic and Hungary. However, in Poland, most household laundry detergents sold are built from STPP.

The phosphate and zeolite industries in Europe

An overview of the phosphate and zeolite industries in Europe is made, including details of production, extraction and manufacturing processes.

The two distinct components to the phosphate industry in Europe are the fertiliser and chemical industries. While the fertiliser industry requires lower levels of phosphate purity, the quantity of phosphorus used is 10 times that of STPP. The chemicals industry supplies foods, detergents and a variety of other industries, of which over 50% of non-fertiliser phosphate is used for detergents.

The European STPP production industry is relatively small, contributing to less than 10% of overall world production. China and India are major producers. A ban on STPP use in detergents in the EU would be likely to reduce the European STPP manufacturing base, and increase the risk of production being moved elsewhere in the world.

In comparison, approximately 50% of detergent zeolites are produced in Europe, the capacity for production exceeds current production, and it is likely that any increased demand for Zeolite A could be met without any additional major investment.

Discharges of phosphorus to surface waters

Estimated quantities of phosphorus discharged to surface water via municipal households are presented and the current situation compared to a number of scenarios, namely:

i. If there were are complete ban of STPP use;

ii. Full implementation of the UWWTD; or,

iii. A combination of i & ii

While industrial sources may be important locally, the two main sources of phosphorus inflows to surface water are municipal wastewater and agriculture. In catchments with low levels of wastewater treatment (i.e. no P removal) municipal wastewater generally represents the largest source of phosphorus. However, where municipal wastewater treatment is of a high standard (e.g. tertiary with P removal), the largest source of phosphorus is from agricultural inputs.

The main agricultural sources are from animal husbandry or fertiliser use, with erosion and run off being the major transport pathways of phosphorus to surface waters.

Phosphorus from detergents contributes an estimated 25% of phosphorus in municipal wastewater requiring treatment in the EU Member States where STPP is still used, Hungary and the Czech Republic. However, the percentage is likely to be higher in Poland, where most detergents are built on STPP.

Phosphorus discharges are reduced considerably by both banning STPP from detergents and improvements to wastewater treatment. However, their combined effect is less than the sum of the individual effects. Even following full implementation of the UWWTD, significant quantities of phosphorus would still be discharged to surface waters, from dispersed populations and population centres less than 10,000, and in non-sensitive areas.

Overall Conclusions and Recommendations

A number of countries have been successful in reducing eutrophication through implementation of measures to reduce phosphorus loads. Notable examples are Lake Geneva in Switzerland, Lake Erie in the USA and Lake Endine in Italy. In all cases the results indicate that a phosphorus reduction of 70%-90%[1] is necessary to significantly reduce eutrophication and improve trophic status.

A ban on the use of phosphate based detergents can achieve a phosphorus load reduction of up to 40% entering surface water bodies, which is not sufficient in isolation to result in any substantial improvements. Furthermore, improvements in wastewater treatment to fully comply with the UWWTD would only result in typical phosphorus reductions of around 30%. As demonstrated by Switzerland, the USA and Italy, the greatest improvements in lakes and rivers were observed where a combination of reduced detergent phosphorus and improved wastewater treatment were implemented, thereby achieving the required 70-90% reduction in external load.

The main sources of phosphorus entering surface waters are from municipal wastewater and agriculture. However, relative contributions vary depending on the nature of catchment landuse activities. For example, in areas without intensive agriculture (lake Geneva's catchment, lake Endine), municipal wastewater is the major source of phosphorus and in these areas improved wastewater treatment has been effective in reducing eutrophication. On the other hand, in catchments with intensive agriculture (e.g. lake Sempach in Switzerland, Wallonia, lower Rhine), agricultural inputs of phosphorus may represent a major source and a combination of measures including improved wastewater treatment and adoption of best land management practices should be employed.

Although the full implementation of the UWWTD will result in substantial reductions in phosphorus loads, discharges of wastewater without phosphorus removal would continue in sensitive areas, where the population is dispersed or in centres up to 10000 population equivalents. Further action to reduce phosphorus loads entering surface waters may be required in these areas.

Based on the results of life cycle analysis, Zeolite A was found to be a suitable alternative to STPP for use a detergent builder. Only minor differences were observed in overall production cost in terms of energy used and sludge produced. Additionally, Zeolite A was found to be non toxic to aquatic fauna and humans and produces less toxic waste by-products when extracted from bauxite than phosphorus containing rocks (e.g. tailings produced include the heavy metals quantities are relatively minor. Furthermore, Zeolite A based detergents is generally accepted by EU Member States and consumers as an efficient and acceptable alternative to STPP based ones. The life cycle analysis concluded that 'any decision on the selection of a detergent builder should be based on other factors'.

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[1] Compared to 100% STPP based detergents and no nutrient removal from wastewater

The EU contributes to less than 10% of the world's STPP production, and employs approximately 1000 people. Therefore, while an EU wide ban on STPP use would direct STPP manufacturing to other large centres, such as China and India, the economic loss of this is not considered to be great in overall EU terms. Additionally, as the current EU capacity for Zeolite A production exceeds the actual production, it could be expected that increased production in this area would result in substantial employment and economic opportunities, with the only a small requirement for additional capital expenditure on infrastructure.

Excessive amounts of phosphorus has long been implicated in the eutrophication of surface water bodies. Therefore, to promote lake/river recovery and improve trophic status it is imperative that phosphorus loads entering surface waters are reduced. Based on the analysis of a number of countries, this phosphorus load reduction should be greater than 70% in order to achieve the above objectives. This can only be achieved through the implementation of a combination of limiting/banning the use of STPP based detergents and improving waste water treatment.

Zeolite A was shown to be a cost-effective alternative, both in terms of socio-economic and environmental impacts, to the use of STPP as a detergent builder in the EU. Therefore measures should be employed on an EU scale to restrict/ban the use of STPPs and switch to detergent builders based on Zeolite A.

Recommendations:

Based on the conclusions outlined above, the following recommendations are made:

- That a general ban on the use of STPP as a builder for household detergents be placed on all EU Member States;

- That EU Member States endeavour to reduce phosphorus loads entering surface waters in order to reverse the long term trend of eutrophication, through a combined approach of banning STPPs in household detergents and achieving full implementation of the UWWTD;

- That further investigations are undertaken on scattered populations and centres less than 10000 equivalents to determine the relative phosphorus contributions originating from these sources, after full implementation of the UWWTD, and what measures are needed and could be employed to reduce these contributions;

- That further investigations be undertaken within agricultural areas to identify 'best management practices', to reduce phosphorus loss to surface waters.

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