TREATMENT OF COMPLEX PHENOLIC COMPOUNDS IN WASTEWATER USING OZONE

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Background

For several years a magnet wire company has had a liquid waste dilemma, on their hands, treatment onsite or transport for treatment offsite.

Five years ago, a major investment was made to treat the wastewater onsite using hydrogen peroxide, heat, iron sulfate, and ultraviolet light. At that time, the phenol levels were significantly higher than those of today in the several thousands (6,000 ppm plus). The wastewater included the reactor distillate generated by the enamels plant and has since been segregated to that plant.

Although this Solarchem system was proven technology, it failed to demonstrate effective treatment within the required time constraints. It also proved to be quite labor intensive, and required a considerable amount of chemicals to operate.

Approximately a year later the decision was made to "cease and desist" all onsite treatment and to reinitiate liquid disposal offsite. To this day, the company has transported the liquid waste offsite for treatment. This option, within the last year, has also proven to be quite expensive as well. The liquid waste handling company used initially has refused to take the wastewater and claims it can no longer treat the waste properly.

Until now, the only other option has been to send it to a company for incineration @ $1.40 per gallon. When one considers that the wastewater is generated as a result of a cleaning process, this is very costly cleaning process especially when 5000-7000 gallons per month are generated which only contains approximately 350 ppm phenol or less.

1.1 Summary

O3 Solutions & Edglo Laboratories conducted pilot studies on two separate occasions: 10/30/98, and 11/3/98 with wastewater taken from the influent tank of a major wire magnet company.

The purpose of this study was to confirm the destruction of phenol through the use of ozone without any additional chemical treatment.

Our observations were as follows:

- Ozone treatment of the wastewater was able to reduce the total phenol concentration to <1 ppm.
- The adjustment of pH was not necessary since it was already caustic (pH 11.61) which is within range for phenol destruction
- There was no additional requirement for chemicals for the reaction to take place (i.e. no catalysts, acids, or bases were required)
- As the contact time was increased, the phenol destruction increased
- The wastewater solution would turn dark brown and then clear with time indicating first the partial oxidation of phenol (probably the formation of quinones), and then complete oxidation of phenol

The bench scale test confirmed that the oxidation of total phenols could be achieved down to levels less than 1 ppm.

The next step would be a full scale pilot study with a complete ozone contacting skid with ORP controller configured to work with the existing system.

The elimination for additional chemicals, existing tanks, pumps, plumbing, etc. and heat are the strong points of using ozone.

1.2 Method

The pilot studies were conducted using raw film department wastewater pumped from a storage tank into a 55 gallon drum. The raw wastewater was then diluted by a factor of 5 with tap water into a 60 gallon low density polyethylene tank.

The wastewater was circulated using a Teal stainless steel centrifugal pump (49 GPM max @ 10 head ft) this was necessary to fit the scale of ozone generator that was used for this study.

The ozone generator was supplied by 03 Solutions which generated ~10 grams/hr @ 3% concentration by weight.

The total volume of wastewater treated was approximately 55 gallons. Test samples were taken at intervals chosen according to the HRT (hydraulic retention time) or elapsed time. The samples were analyzed on a Bran & Luebbe colorimetric auto analyzer according to the 4-AAP method.

1.3 Wastewater Characterization

A 55 gallon drum of raw wastewater was brought back to Edglo Laboratories on October 15, 1998.

Our analysis of the wastewater showed the following:

Parameter	Result
Appearance	Tan color
PH	11.61
Total Phenols, ppm Raw Film Dept.wastewater	437 ppm
Total Phenols, ppm 4-AAP Study 1 (diluted)	87.4 ppm
Total Phenols, ppm 4-AAP Study 2 (diluted)	48.8 ppm
Phenolic Compounds Present GC/MS Method 8270	Phenol 4-methyl phenol 2,4 dimethyl phenol Bis (2-ethylhexyl)phthalate

1.4 Results and Discussion

Table 1 shows the results obtained from the pilot study. The wastewater was diluted with tap water to yield the initial concentration for both studies.

Table 1

Sample	Phenol Concentration, ppm	Elapsed Time (min)
0	87.4	0
1	30.8	66
2	9.6	133
3	3.63	200
4	0.25	330

The wastewater was treated to less than 1 ppm in about 5.5 hours using the above mentioned ozone generator at a flow rate of 2.50 GPM for study 1 conducted 10/30/99 (Table 1). A contact chamber was added to increase the HRT this allowed for an increased phenol destruction rate.

Table 2

Sample	Phenol Concentration, ppm	Elapsed Time (min)
0	48.8	0
1	29	60
2	10.4	120
3	3.05	180
4	0.42	240
5	0.30	300

The wastewater was treated to less than 1 ppm in about 4 hours using the above mentioned ozone generator at a flow rate of 5.00 GPM for study 2 conducted 11/3/98 (Table 2). The contact chamber was still on line but was not used (i.e. no HRT).

The rate of phenol destruction was significantly less at a flow rate of 5.00 GPM with no HRT compared to the study conducted on 10/30/98 with a flow rate of 2.50 GPM and HRT.

1.5 Conclusions and Recommendations

The results conclude that the destruction of phenols under alkaline conditions can be accomplished to yield a final concentration of <1 ppm. The need for additional chemicals was not necessary to accomplish this task.

It would be our recommendation that an on-site pilot study be conducted on a trial basis to confirm these findings on a large scale. The on-site pilot study would incorporate a full scale system which is skid mounted and uses an ORP controller for endpoint destruction determination. The full scale system also would allow for increased ozone concentrations in contact with the wastewater which would allow for an increased phenol destruction rate.