New Developments in Air Pollution Control at Hyperion Treatment Plant

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Abstract The City of Los Angeles Hyperion Treatment Plant has 13 APC facilities for foul air treatment at liquid, solids and gas handling processes. In 2004 and 2005, several new facilities have been constructed or modified with the objectives to further reduce odorous emissions and to minimize operational and maintenance requirements. This contribution discusses pre-chlorination of the wastewater, the use of single-stage carbon towers at the secondaries, and the start-up of a new centralized facility for air treatment at the primaries. Past plant pilot-scale research on odour control technologies will be briefly presented.

Keywords Activated carbon, air pollution control, odour, scrubbers, automation

Introduction

The City of Los Angeles Hyperion Treatment Plant (HTP) is located in Playa del Rey, California, and treats an average wastewater flow rate of 350 mgd. The plant underwent a major expansion in the 1990's and currently has enhanced primary treatment, full secondary treatment with high purity oxygen reactors and 20 egg-shaped thermophilic anaerobic digesters for Class A biosolids production.

Because of the close vicinity to residential communities, HTP has always put a large emphasis on odor control. Odorous emissions have greatly been reduced over the past 15 years and the number of odor complaints has steadily decreased. Still, there is a continuous need for further improvements in odor abatement by reducing fugitive emissions and increasing the capacities of APC facilities. In addition, because economical constraints have reduced the number of plant staff, there is a need for reducing operational and maintenance requirements by automation of APC facilities. In this contribution, we present an overview of HTP's odor control strategy and highlight the latest developments that have been implemented over the past two years.

Existing APC Facilities

HTP has thirteen APC facilities that are located at various wastewater treatment, solids handling and gas handling processes, as summarized in Table 1. Most facilities were built in the early 1990's and use single-stage cylindrical packed tower scrubbers and dual-bed activated carbon towers. The scrubbers are usually operated with sodium hypochlorite and sodium hydroxide; chemical metering is automatic by pH controllers (pH > 9.0) and ORP controllers (ORP > 600 mV). APC facilities of later origin, such as at the Primary Battery

Effluent Channel and Intermediate Pump Station, use three-stage cylindrical scrubbers, which achieve a higher degree of cleaning but also require more maintenance.

All APC facilities at HTP are regulated by South Coast Air Quality Management District (Diamond Bar, California), which regulates air emissions in the Southern Californian area. APC permits contain requirements for emissions, equipment operation and maintenance, monitoring and record keeping. For HTP, the most important requirement is that the H_2S concentration in APC exhausts to the atmosphere does not exceed 1 ppm_v. Table 1 demonstrates that H_2S concentrations are relatively high in facilities for wastewater treatment, in particular before and at primary treatment. H_2S concentrations are significantly less at secondary treatment. Waste air from solids handling processes at HTP usually does not contain H_2S.

H_2S concentrations in waste air before and at the primaries usually show considerable variation over the day. Using the waste air from the Influent Sewers Channels as an example (Figure 1), concentrations are typically the lowest in the morning, but they rise in the afternoon and remain relatively high throughout most of the night. The H_2S limit of 1 ppm_v must be met at all times, therefore, APC facilities are usually designed for removing H_2S with >99 or 99.5% efficiency. Even though this efficiency is always met, evaluation of several APC facilities has shown that odor removal efficiencies may be somewhat less. This would suggest that the foul air may contain other odorous compounds that are removed with a lower efficiency than H_2S, but the identity of these compounds remains unknown.

Table 1 Overview of APC facilities at Hyperion Treatment Plant (1992 – 2004).

Location	APC facility	H_2S concentr.[a] (average/peak)	Design air flow rate
		(ppm_v)	(m^3/h)
Influent Sewer Channels	2 scrubbers, 3 carbon towers	21 / 35	31,500
Headworks	3 scrubbers	6 / 19	181,900
Primary Batteries B and C	3 scrubbers, 3 carbon towers	31 / 90	17,200
Primary Battery D	2 scubbers, 2 carbon towers	49 / 95	12,000
Primary Batteries Effluent Channel	1 scrubber (3-stage)	65 / 110	34,000
Intermediate Pump Station	2 scrubbers (3-stage)	17 / 50	68,000
Secondary Reactors (Influent Channels)	3 facilities, each with 2 scrubbers, 2 carbon towers	4 / 27	4,900
Secondary Reactors (Reactor Vents)	3 facilities, each with 2 scrubbers	0 / 10	5,500
Waste Activated Sludge Thickening Facility	3 scrubbers	0 / 0	40,800
Digester Screening Facility	2 scrubbers in series	0 / 0	42,500
Truck Loading Facility	2 trains of 2 scrubbers in series	0 / 0	149,600
Gas Handling Facility	1 carbon tower	0 / 0	1,700

[a] Data over July 2005 from daily analyses.

New Developments

HTP has recently implemented several modifications and expansions for further reducing the emission of odors. These modifications are based on plant investigations to identify odor sources, monthly meetings with citizen's from neighbouring communities, and interactions with regulatory agencies. A multi-directional approach is currently being developed with the following main objectives:

- Reduction of fugitive emissions.
- Centralization of APC facilities while enlarging the capacity.
- Automation of existing and new APC facilities (remote monitoring and control).

Prechlorination of wastewater

HTP completed the construction of the Pre-Chlorination Facility (PCF) in the summer of 2004. The design of this facility is relatively simple and consists of two 7800-gallon tanks for sodium hypochlorite storage, chemical transfer pumps, and ancillary equipment for level control in the storage tanks. The pumps transfer sodium hypochlorite at a flow rate of about 18 gpm to the six Aerated Grit Basins between the Headworks and the Primary Batteries. The objective of the PCF is to reduce fugitive emissions of H_2S, primarily from the Primary Batteries, by reaction of dissolved sulfide in the wastewater with sodium hypochlorite. The advantages of the PCF are:

- Hydrogen sulfide is eliminated at the source, i.e., in the wastewater, rather than by APC post-treatment.
- The PCF allows for an immediate and proactive response to situations for which an increase in odorous emissions can be expected.

Currently, HTP daily injects sodium hypochlorite into the Aerated Grit Basins during four periods ranging from 15 to 50 minutes in the afternoon and early evening. These intervals were selected because they coincide with relatively high sewage flow rates to the plant (Figure 1), which is believed to be one of the causes of the relatively high incidence of odor complaints during the late afternoon and early evening. Pre-chlorination of the wastewater

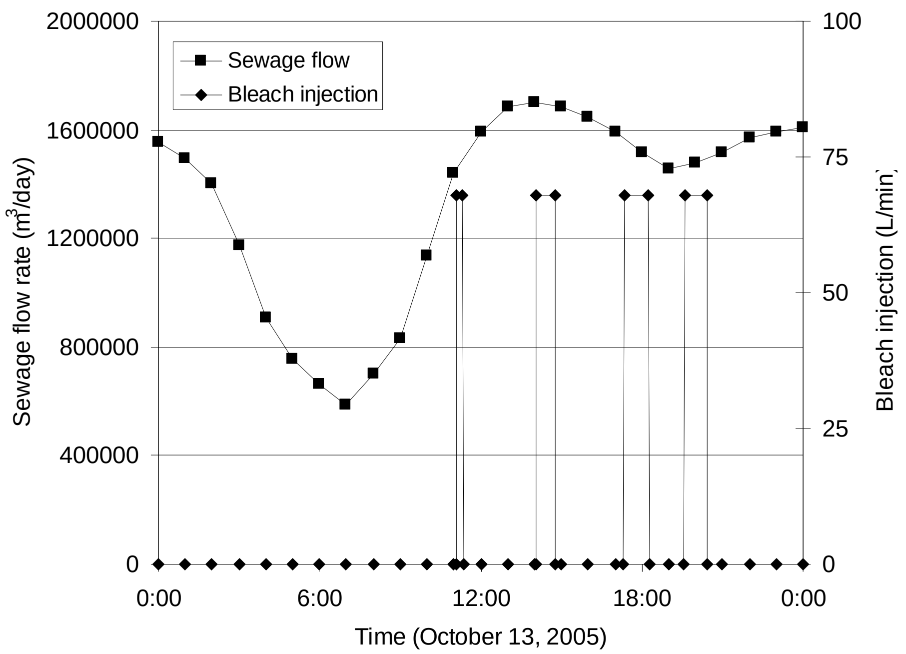

Figure 1 Addition of sodium hypochlorite to Aerated Grit Basins.

has a noticeable effect as the number of odor complaints has been reduced, however, the overall sodium hypochlorite usage by APC has significantly increased. Further research of the exact correlation between pre-chlorination and fugitive H_2S emissions will be needed to optimize the performance of the PCF at the lowest cost.

APC modifications at secondary reactors

The APC facilities for foul air treatment from the secondary reactor influent channels was built in the early 1990's. After more than 10 years of operation, the scrubbers required extensive maintenance, nevertheless a decline of performance was observed so that H_2S removal was mostly accomplished in the carbon towers as the second stage of treatment. As the foul air contains relatively low H_2S concentrations (Table 1), it was decided to operate the scrubbers without any chemicals (recirculation of water only) and mainly rely on the activated carbon towers for removal of H_2S. This modification was partly motivated by the availability of a new type of activated carbon (Midas OCM, U.S. Filter), which has a relatively high capacity for adsorbing H_2S (XX g/mL).

Figure 2 demonstrates that the foul air from the secondary reactor influent channels contained H_2S in the range of 2 to 30 ppm_v, with relatively high concentrations in the summer of 2005. Single-stage treatment in towers with Midas OCM activated carbon reduced the H_2S concentration to less than 1 ppm_v for over 12 months, but breakthrough was observed after 13 months of operation. Figure 3 summarizes the results of odour analyses. Odour removal efficiencies in the carbon towers varied between 40 and 85% and a declining trend over time can be observed. It is interesting to note that the odour removal efficiency is significantly less than the removal of H_2S, suggesting the presence of other odour compounds that are removed less efficiently. The odour at the secondaries is often described as musty, unlike the typical sewage odour at the primaries that is mainly caused by the

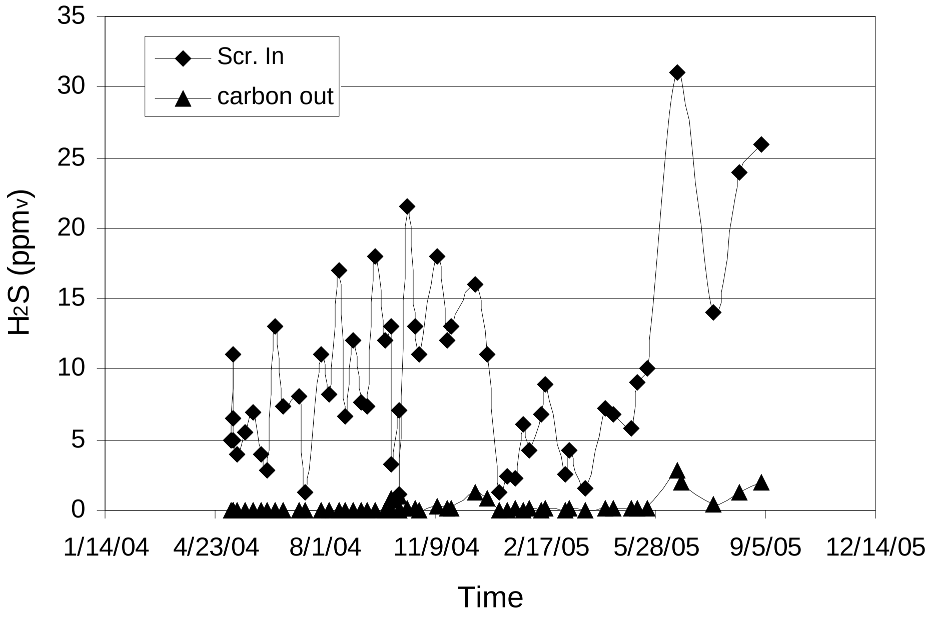

Figure 2 H_2S removal in carbon towers with Midas OCM activated carbon at secondaries.

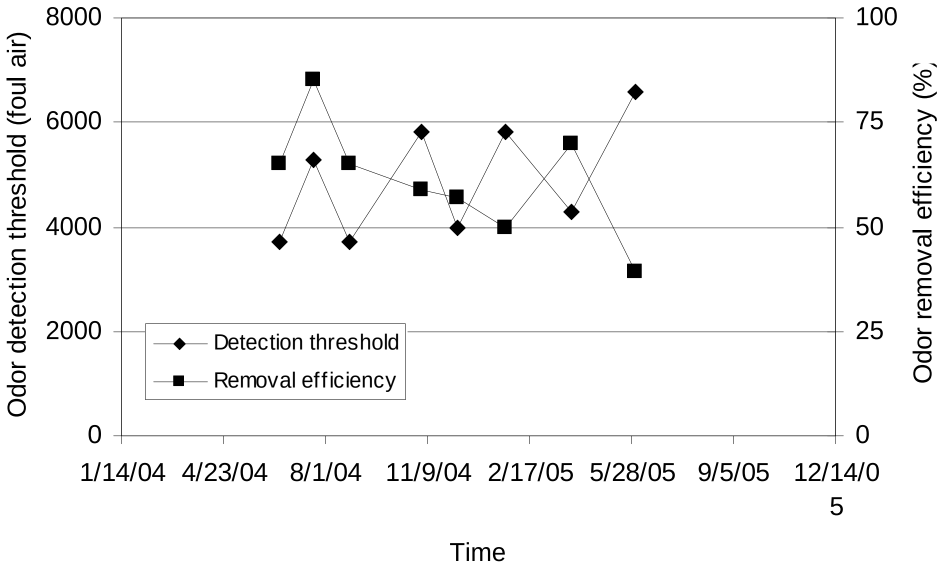

Figure 3 H_2S removal in carbon towers with Midas OCM activated carbon at secondaries.

presence of H_2S. As the foul air from the secondaries contains very few other sulphurous compounds, the identity of musty compounds must be sought elsewhere.

Table 2 summarizes concentrations Volatile Organic Compounds (VOCs) in the foul air from the secondary reactor influent channels, which is analysed about once every two months. The concentrations are typically in the lower ppb range, but VOC removal by the Midas OCM activated carbon towers has not been observed, even if only after two months of operation. This would suggest that this carbon has a highly selective capacity for H_2S, or that the foul air contains a relatively high total VOC concentration that causes rapid saturation of the carbon before breakthrough of H_2S occurs.

Overall, the use of carbon towers as stand-alone treatment instead of as a polishing step after scrubbers proved to be very beneficial for HTP. Specific advantages include:

- No chemical usage, hence reduced operational costs and improved safety conditions.
- Less operational and maintenance requirements.

Clearly, this approach is only a viable alternative if foul air H_2S concentrations are relatively

Table 2 VOC concentrations (ppb_v) in foul air from influent channels of secondary reactors.

Aromatic, non-chlorinated	**Concentration**	**Aliphatic, chlorinated**	**Concentration**
Benzene	2.2 – 4.5	Carbontetrachloride	<0.3
Toluene	94 – 510	Chloroform	55 – 109
m,p-Xylene	6 – 23	1,1-Dichloroethane	<0.2
o-Xylene	<0.2 – 6	1,2-Dichloroethane	<0.5
		1,2-Dichloroethane	<0.2
Aromatic, chlorinated	**Concentration**	Dichloromethane	17 – 62
Benzyl chloride	<0.7	Methylchloroform	<0.2 – 2.5
Chlorobenzene	<2	Tetrachloroethylene	12 – 582
m-Dichlorobenzene	<0.3	Trichloroethylene	2 – 8
o-Dichlorobenzene	<0.5	Vinylchloride	<0.3
p-Dichlorobenzene	14 – 85	Vinylidenechloride	<0.2 – 7

low. In this specific example, the relatively high cost of Midas OCM activated carbon was offset by the savings on chemical use by the scrubbers and the reduction of manpower required for operation and maintenance of the equipment. However, it should be noted that our main objective at secondaries is to achieve complete removal of H_2S. Hence, the use of Midas OCM activated carbon towers as stand-alone units may be less feasible if also a high degree of odor and VOC removal is required.

Centralized scrubber facility at primaries

The primary batteries have been identified as one of the major areas of concern with respect to odorous emissions at HTP. Hence, most of recent APC developments are focused on this area. Several approaches are simultaneously being followed to bring odorous emissions to a minimum. First, the decks on the primary battery tanks are currently being replaced with airtight aluminium covers. This is a multimillion-dollar project, taking place over several years. At present, the decks on Primary Battery A have been replaced and work on Primary Battery B has started. Primary Batteries C and D are expected to have new covers by the end of 2006. It is expected that the new covers will greatly reduce fugitive emissions.

The second approach is the replacement of existing APC facilities in the primaries area by a new APC facility with the following objectives:

- To centralize APC. As shown in Table 1, HTP had several APC facilities treating the foul air from: Primary Batteries B and C; Primary Batteries D; Primary Battery A and the Effluent Channel. In the new set-up, the foul air will be collected from these areas and treated by the centralized facility on the decks of Primary Batteries B and C (Figure 4).
- To increase the capacity of foul air treatment. With the old facilities having a combined capacity of 63,200 m^3/h, the centralized facility will have a capacity of 102,000 m^3/h after phase I (completed in August 2005 with the construction of three scrubbers) and 204,000 m^3/h after phase II (addition of three scrubbers, bringing the total to six).
- To minimize the demand on operation staff. This is done by remote control and operation.

The centralized facility uses six scrubbers of 20,000 cfm each and each scrubber is followed by two dual-bed carbon towers for after polishing (Figure 5). The scrubbers are from U.S. Filter (R.J. Environmental) and contain three stages in which H_2S removal can be separately controlled by the additions of sodium hypochlorite and sodium hydroxide. The centralized facility uses state-of-the-art technology and has many advanced features:

- Make-up is first passed through a water softener to reduce the rate of solids build-up on the packing.
- The second stage has the possibility of sulphuric acid addition, instead of sodium hydroxide, to facilitate the removal of organic sulphides.
- Operation of the facility is possible from the field in manual or automatic mode, or remotely from the plant's control system in the central control room. Figure 6 shows the display in the control room, which provides the operator a complete overview of the basic operations of the facility. Remote operation requires only one operator, and can be done without assistance from the field.
- Many parameters are continuously being monitored for display in the field as well as in the central control room. Each scrubber/carbon tower train sends over 70 signals to

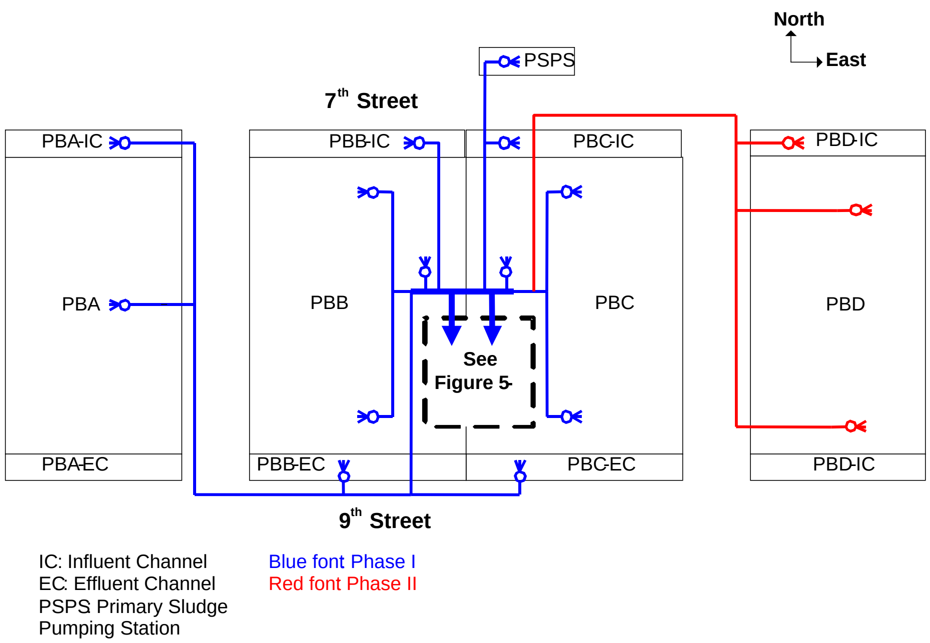

Figure 4 Air ventilation system to new centralized scrubber facility at primaries.

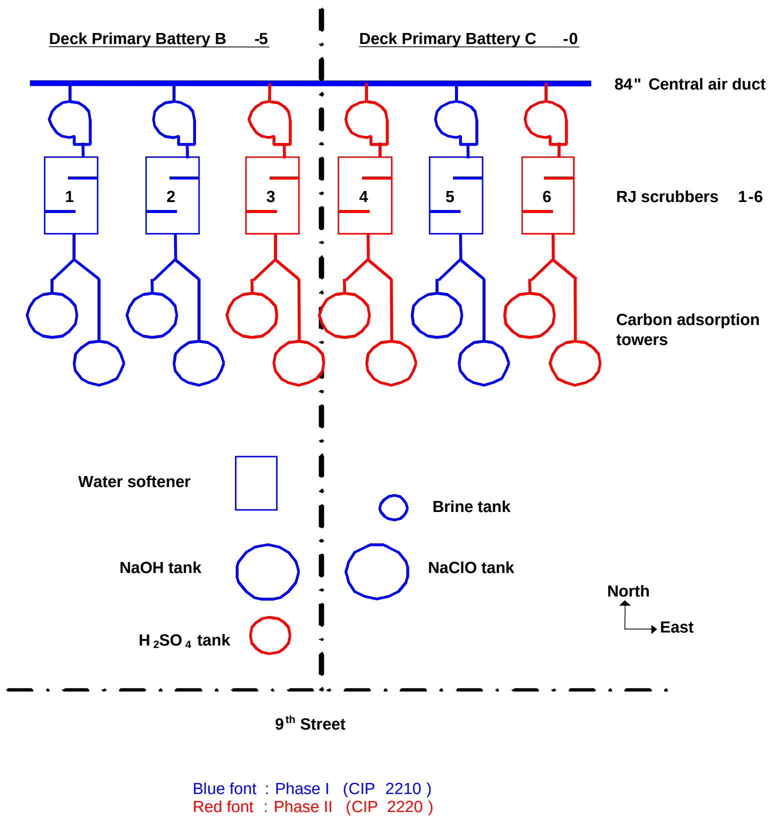

Figure 5 Lay-out of new centralized scrubber facility at primaries.

the plant's control system, and allows for continuous monitoring of equipment status, operational parameters, air flow rates in the ventilation system, and the levels of chemicals in the storage tanks.

- The facility is operated by several safety interlocks, which will automatically cause the shutdown of specific equipment or the entire scrubber/carbon tower train depending on the nature of the failure.

Phase I with the installation of three scrubbers was completed in September 2005. Tests to determine operational parameters for optimum performance are currently conducted, and will be presented at the conference.

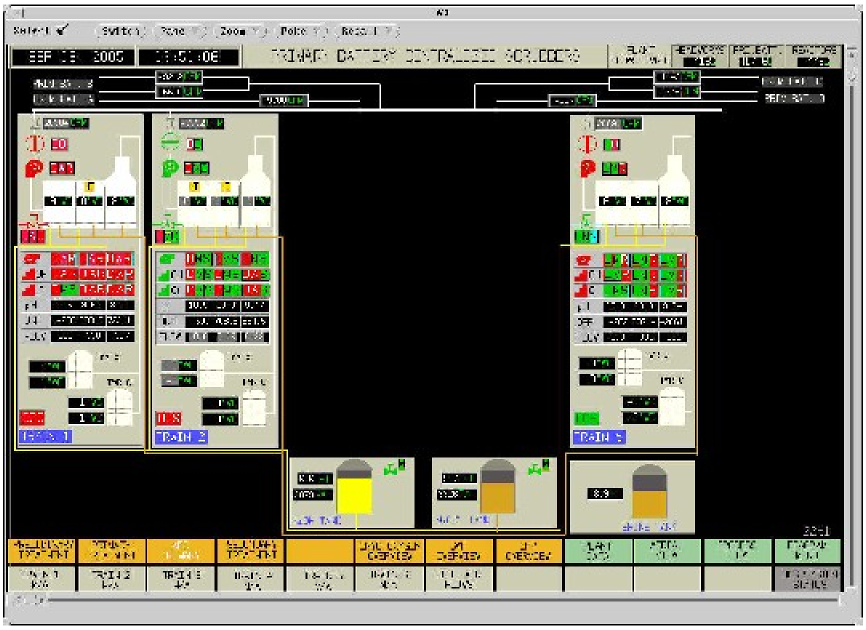

Figure 6 Remote control and operation of centralized scrubber facility at primaries.

Conclusions

The economic, political, social and regulatory benefits of the project to the City of Los Angeles will be discussed at the presentation.

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