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Corrossion Analysis in sea water ballast tank in hull/ship

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Absract:-*Ballast tank is an important part of ship. As sea water is highly corressive towards mild steel,rate of ballast tank corrosion is important factor which decides ship's safe working life. Continuosly submerged uncoated steel corrodes at approximate rate of 0.1 to 0.2 mm/year Literature survey was carried out to analyse different methods to counter the corrosion problem. Some of the suggested measures are (a) introducing low sulpher inert gas,(b) using improved coating schemes ,(c) using DNV approved marine points. VOS (Ventury Oxygen Stripping) system removes 95% of dissolved oxygen from ballast water in 10 seconds. The low oxygen gas is created by combustion of low sulpher diesel in a device similar to tanker inert gas generator. VOS is very effective system to protect ballast tank from corrosion.*

INTRODUCTION

Here we consider For industry builds new cargo (product carrier) ships and repair old ships. While we visiting oil tanker hull we found corrosion in sea water ballast tank. We know that Sea water is a highly corrosive electrolyte towards mild steel. So main cause of corrosion in ship is sea and rain water. Standard used for coating gives 15 year life to protect sea water ballast tank and double side-skin spaces of bulk carriers from corrosion, erosion and cavitations mainly. So it is necessary to improve life of coating and reduce the effect of corrosion. The vast majority of the world's ships are constructed of carbon steel, which corrodes rapidly when exposed to oxygen and water. A ship's ballast tank is one of the most corrosive environments on earth. Where continuously-submerged uncoated steel corrodes approximately 0.1 to0.2millimetersperyear(mm/yr)

Corrosion is defined as the deterioration of materials by chemical interaction with their environment. The term corrosion is sometimes also applied to the degradation of plastics, concrete and wood, but generally refers to metals.

By corrosion following losses carried out,To reduce following losses caused by corrosion
The country loses about 3-4% of GDP due to Corrosion every year which translates to a staggering figure of over Rs 2 Lac Crores per year.
LOSSES:

- Reduced Strength
- Downtime of equipment
- Escape offluids
- Lost surface properties
- Reduced value ofgoods

Find the alternate method which is different than standard(PSPC) used today and more economical than PSPCTo derive new anticorrosion technology from basic concept removing oxygen from the ballast tanks will limit the oxidation of metallic structures and thus greatly reduce the problems associated with corrosion.

- Find environment friendly techniques for reduce corrosion rate of sea water ballasttank

Pspc standard by IMO

- A standard designed to achieve a *target* coating lifetime of 15 years in dedicated seawater ballast tanks and double side-skin spaces of bulk carriers
- Introduced after significant losses of ships due to corrosion in ballast tanks
- Applicable to dedicated WBT of all new buildings >500 GT and double side-skin spaces in bulk carriers of 150m in length and above
- Improved corrosion protectionvia:

- Improved steelwork, surface preparation and cleanliness prior tocoating
- Improved application control of coatingschemes
- Use of pre-qualified anticorrosive schemesonly

- The standard is for New buildingsonly
- The IMO MSC.215(82) Performance Standard for Protective Coatings was adopted on 8th December2006

Common Structural Rules :
The IACS agreed Common Structural Rules (CSR) for Bulkers and Tankers came into effect on 1st April 2006

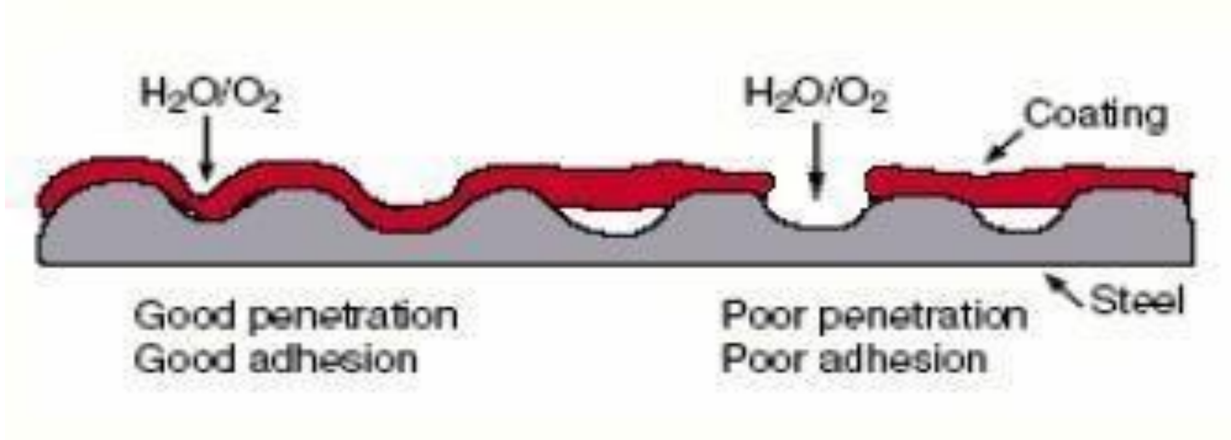
The CSR's address a number of aspects about the design and structural integrity of Tankers >150m and Bulk Carriers >90m

They also acknowledge the importance of coatings for water ballast tanks

The CSR's make a provision for a coatings standard by stipulating the mandatory adoption of the IMO PSPC once the standard has been adopted.

The most important thing to note is the timing. The CSR state that the requirement for IMO Type approved coating systems comes into effect IMMEDIATELY the IMO PSPC is adopted.

For CSR vessels being contracted from 8th December 2006, the IMO PSPC applies Repairing the corrosion protection system of water ballast tanks is very difficult and very costly. It is virtually impossible to get the tanks back to the condition when the vessel was new.



coating on steel surface of steel in SWB with poor Coating

Example repair costs:

- Steel preparation and application costs <u>$35 to$45/m2</u>
  - HPFWW and Degreasing
  - Staging
  - Dry Blasting to Sa2 orSa2½
  - 1 stripe + 2 full coats
- Paint - depends on system chosen
- ULCC, VLCC about250,000m2
- Total cost for total tanks **<u>$9 to $11m +paint</u>**

- At 1500m2 per day, this could take150days+

  (Riding crews are often used for such large jobs to reduce out of service time)

International Paint produce high quality marine coatings

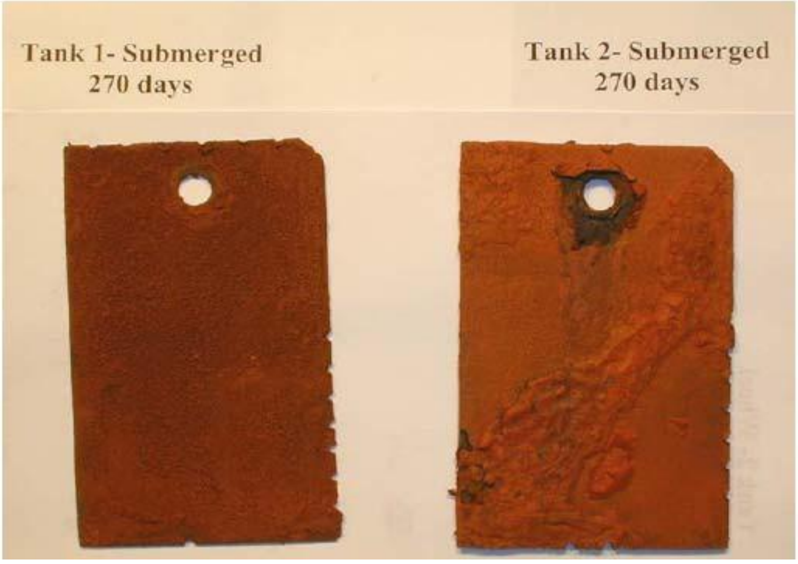
- The coatings are developed and tested rigorously before they go to market

- International Paint has always used Marintek/DNV ballast tank approvals as standard. In fact International has worked closely with Marintek/DNV from the very beginning of the Ballast Tank Coating Protocol project and it was this project that evolved into the industry acceptedtest.

- A coating system is only as good as the surface preparation and steel work quality that it is being applied over. Even the DNV test is carried out over Sa2.5 grit blasted steel. Any down grading from that steel preparation standard will not have been shown to give the required 15 year lifetime..

The experimental data revealed that overall corrosion rates were low under de-oxygenation conditions as compared to control conditions. Comparison of experimental data after 30 days exposure indicated that under de-oxygenated conditions the corrosion rates were reduced by 40 percent in the splash zone environment, 48 percent in the submerged condition, 78 percent in the humidenvironmentand14percentintheburiedconditionAfter270daysthecorrosionrateswere lower by 38 percent in the splash zone environment, 84 percent in the humid environment and 20 percent in the buried condition.

The untreated submerged condition tests showed an average corrosion rate of 0.24 mm/yr for control conditions. This is consistent with published estimates (La Que, 1975). As expected, it is the empty ballast tank condition that exhibited the highest corrosion rate for untreated coupons. The corrosion rate of untreated coupons in the humid condition was as high as 1.19 mm/yr, and stabilized at approximately 0.55 mm/yr by 270 days.



Corroded plates after 270 days exposure in submerged Environment.

Life cycle COST ANALYSIS

The study VOS system is for a 5500 TEU Container Ship. The approximate total ballast tank surface area is 30,000 m^2 Class rules for corrosion margins differ for containerships so this study will use the CSR corrosion margins for bulk carriers. It is expected that corrosion allowances for container ships will not exceed that of bulk carriers. The ballast pumps for this vessel are 2 x 1,000 m^3 /hr. though only one is used at a time. The vessel is on transpacific liner trade with four port calls on a 36-day round trip, making10 trips per year. It is assumed the vessel takes on 2,000 m^3 of ballast at three ports and discharges all 6,000 m^3 ballast at the bunkering port. Therefore the total annual volume ballast treatment is 60,000 m^3. Total running time of the VOS system is 120 hours. A vessel on longer voyages would have fewer port calls, fewer ballast operations, lower annual VOS operating cost, and lower VOS life cycle cost, and vise versa.

Wherever possible this cost analysis will use the most conservative numbers available. For example, when evaluating the running cost of the VOS system, a high fuel cost is used. When evaluating the off-hire time during dry docking, a low time-charter rate is used.

Steel Corrosion :

The corrosion protection effect of sacrificial anodes is known (70 percent). The BMT testing did not include coupons with anodes attached. Therefore observed corrosion rate for full ballast tank condition will be reduced by a factor of 70 percent for both treated and untreated results. Also, it is unclear what effect cathodic protection would have in the Splash Zone in the shipboard environment. Therefore, despite a 38 percent lower corrosion rate for the VOS-treated steel in the Splash Zone condition, this result will not be in corporate in to the cost analysis.

Irrespective of the duration of voyages, the study vessel would the majority of the year with most ballast tanks empty. The corrosion rate analysis will incorporate submerged condition results multiplied by a cathodic protection factor of 70 percent for ballast-filled condition. To use the most conservative analysis, it will be assumed that the vessel's ballast tanks willspend50percent of the time in ballast.

Tank Identification Condition Corrosion Rate at 270 days

Submerged 0.24 mm/yr

To determine the expected corrosion rate for both submer ged results (0.24 mm/yr), the observed rate is multiplied by a cathodic protection factor, 0.3 (1 – 0.7).

0.24 mm/yr x 0.3 = 0.07 mm/yr

As described above, the study vessel is expected to spend half the year with cargo and half the year in ballast. Thus, the following formula incorporates the humid condition results to calculate expected annual corrosion rates (CR) for treated and untreated condition

$CR_{untreated}$ = (0.07 mm/yr x 0.5 yr) + (0.55 mm/yr x 0.5 yr) = 0.31 mm/year

$CR_{treated}$ = (0.07 mm/yr x 0.5 yr) + (0.09 mm/yr x 0.5 yr) = 0.075 mm/year

As shown in above calculation, when these corrosion rates are used to calculate the expected time to exceed the CSR corrosion allowance, the results indicate that within the 25-year design life steel renewal is not expected when using the Ventury Oxygen Stripping system. In fact the minimum indicated time to exceed the corrosion margin using the VOS system is 32 years. The calculations show most structures will not exceed the corrosion margin until 40 years. The maximum expected time to required steel renewal for the ballast tank compartments of a CSR- compliant Panama bulk carrieris conservatively estimated to be53years.

Methodology :

Our methodology to solve this problem is implementation and use of VOS(venture oxyzen stripping) system in sea water ballast tank as deoxyzenation system.

An increasing percentage of the world's shipping fleet is of double hull construction. As a result of this design evolution, the traditional methods of maintaining ballast tank structural steel, cathodic protection and coatings, are becoming very costly.

Ship structures while in service are likely to be subject to age related deterioration such as corrosion wastage, fatigue cracking or mechanical damage (e.g., local denting). Maintenance and repair of aged structures is also very costly and complex It is thus of great importance to develop advanced technologies which can allow for proper management and control of such age related deterioration.

As data refers now a days techniques used for coating of sea water ballast tank is standard developed IMO termed as PSPC(performance standard for protective coating).

- at present the standard used for coating of seawater ballst tank is PSPC(performance standard for protective coating).the IMO(international maritime organization) MSC.215(82) Performance Standard for Protective Coatings was adopted on 8th December2006,
- A PSPC standard designed to achieve a *target* coating lifetime of 15 years in dedicated seawater ballasttanks.

Following are alternate way which can be thinked for protecting seawater ballast tank for 25 or more than 25 year from corrosion,

- Tanks are constructed in grade A steel, have a standard PSPC (Performance Standard for ProtectiveCoatings)coatingandareequippedwithsacrificialanodes.Increasetheplate thickness.
- Tanks the corrosion allowance has been doubled avoiding steel replacement throughout the economical lifetime of the ship.
- Tanks are constructed in corrosion resistant steel(CRS)

all above listed are alternate way of increasing protective life of seawater ballast tank but still problem face in above method is it increase in lifecycle cost of ship and these methods are not economical for ship builder and ship owner.

But still most economical and also saving in life cycle cost of ships and also increase protection life of sea water ballast as 25 years and more that is VOS (Venturi Oxygen Stripping), This paper presents a life cycle cost benefit analysis of the Venturi Oxygen Stripping ballast water treatment systemas a new alternative method of ballast tank protection.

The engineering challenge has been to develop a de-oxygenation system that is practical for the marine environment, and costs less than the corrosion it's designed to stop.

The VOS system both removes dissolved oxygen from ballast water as it is drawn in to the vessel and inerts ballast tanks with low oxygen gas as they are emptied. Except for tank entry safety, ballast tanks are permanently maintained in a low-oxygen condition.

TheVOSsystemdoesnotremove100percentofoxygenfromballastwaterorfromemptytanks. This could potentially lead to the growth of sulfur-reducing bacteria (SRB), which cause corrosion. Sinceeven0.03milligram sperliter (mg/l)of oxygen is toxic to SRBs. The VOS system maintains an oxygen concentration above this level to suppress the growth of corrosive bacteria.

Description of Venturi Oxygen Stripping

The VOS system removes 95 percent of dissolved oxygen from ballast water in under ten seconds. De-oxygenation is accomplished as ballast water is pumped into the vessel by mixing very-low oxygen inert gas(mostly nitrogen with small amounts of carbon dioxide and only trace levels of oxygen) with the ballast water through venturi injectors installed in the ballast piping (see photographs below). As ballast is drained, inert gas is introduced into the emptying tanks. This element of the treatment complies with ABS *Guide for Inert Gas Systems for Ballast Tanks*

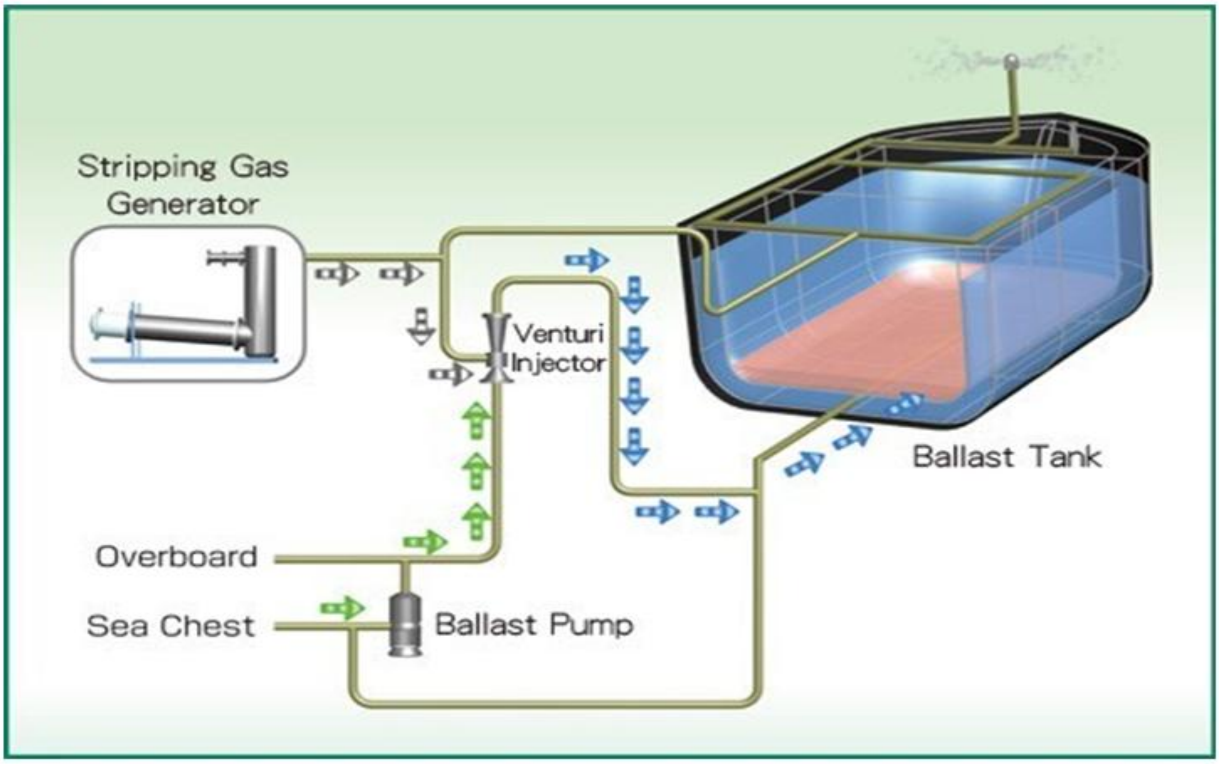
The low-oxygen gas is created by combustion of low-sulfur diesel in a device that is similar to tanker inert gas generators (see above). The size of the venturi injectors and the

Inert gas generator vary with the capacity of the ship's ballast pumps. The dimensions of the inert gas generator unit for a 5500TEU container ship are 3.5meters x 1.5meters x 3.0meters high.

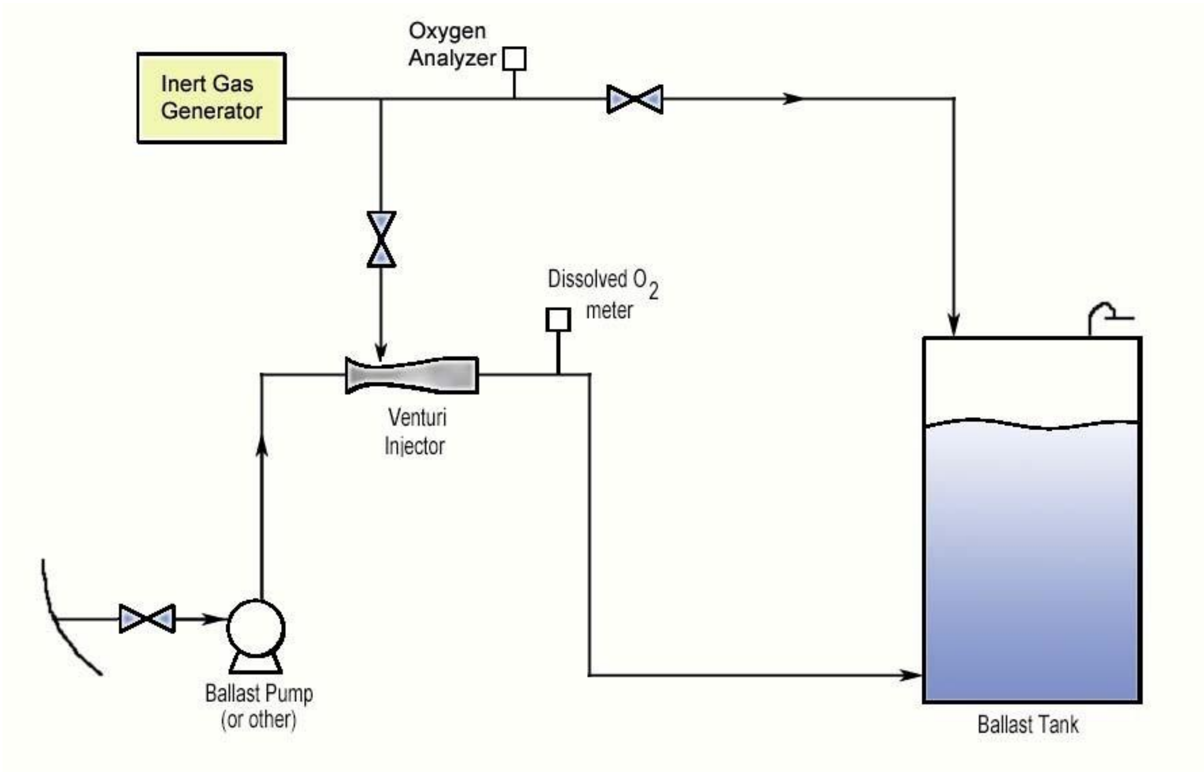
venture injector

As with traditional tanker inert gas generators, the gas is passed through a vertical cooling water section prior to introduction into ballast tanks or ballast water. The gas sulfur concentration is reduced to parts per billion range, far below a level that creates a sulfuric acid corrosion concern. In natural water within pH range from 4 to 10 there is no effect on corrosion rates of ship building steel. Therefore, acid attack is not an issue with the VOS system.

The gas is mixed with the ballast water using a venturi injector manifold that creates a micro-fine bubble emulsion where dissolved oxygen quickly diff uses out of the water into the gas. Because adding carbon dioxide in solution forms both carbonic and carboxylic acid, the pH of treated water is also reduced to between 5.5 and 6.



Venturi oxygen stripping system cycle



simplified diagram of VOSsystem

as from figure we easily can understand the working of venture oxygen stripping(VOS) system, first of all the ballast pump pumps sea water from sea with oxygen level 7 mg/litre into venturi injector, that time the inert gas generator will generate the inert gas from combustion of low sulpher diesel, the inert gas and pumped sea water will mix in venturi injector that time the oxygen from sea water micro-fine bubble emulsion where dissolved oxygen quickly diff uses out of the water into the gas .the diffused oxygen will flow en into the sea or atmosphere which is environment friendly and which is peak need of environment. then the sea water then entered in seawater ballast tank where it perform its work efficiently. oxygen analyger used to analyze how much oxygen level in sea water ballast tank. so this method 's working principle is easy and simple. This is pollutant free method.

Result analysis :

The result analysis for providing protection to sea water ballast tank by the deoxygenation system like venture oxygen stripping we get following benefits/advantages,VOS system is highly economical for protecting of sea water ballast tank and increasing life of sea water ballast tank,by result of using this system steel renewal at 15 year can bereduced,

Corrosion slowed by 85 percent by VOS system translates to:

- Less coatingmaintenance
- Less steelrenewal
- Shorter off-hire time indrydock
- Significantly reduced wastage of sacrificialanodes
- Significant savings over the life of the of thevessel

Suitability

The VOS system is easily installed and simple to use despite the complex forces at work.

- A simple mechanism with few movingparts
- System is integrated into existing ballastcontrols
- The majority of components are familiar to ships'engineers
- Monitoring and control systems are straightforward and easy tounderstand
- Designed for inexpensive retrofit or shipyardinstallation
- Employs durable alloys for many years ofservice
- Suitable for a variety of vessels including tankers, offshore oil rigs, container ships, bulk carriers,etc.

Safety benefits include:

- Complies with ABS Guide for Inert Gas Systems for BallastTanks
- Reduction in explosion hazard associated with oil leaks into double-hulled tanker ballast tanks
- No transportation of, or human exposure to, hazardousmaterials
- No discharge of toxiccompounds

CONCLUSION

The problem of corrosion in sea water ballast tank is very critical problem which affect the life of ship structure so I am trying to solve this problem by increasing life of seawater ballast tank by providing corrosion protection, I want to implement the environment friendly techniques that is venturi oxygen stripping, its involve deoxygenetion of seawater ballast tank so very low oxygen remain in ballast water so oxidation cant occur, so by this we can get protection of SWB against corrosion.

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