

The Electro Coagulation Wastewater Treatment System

(Patent Pending)

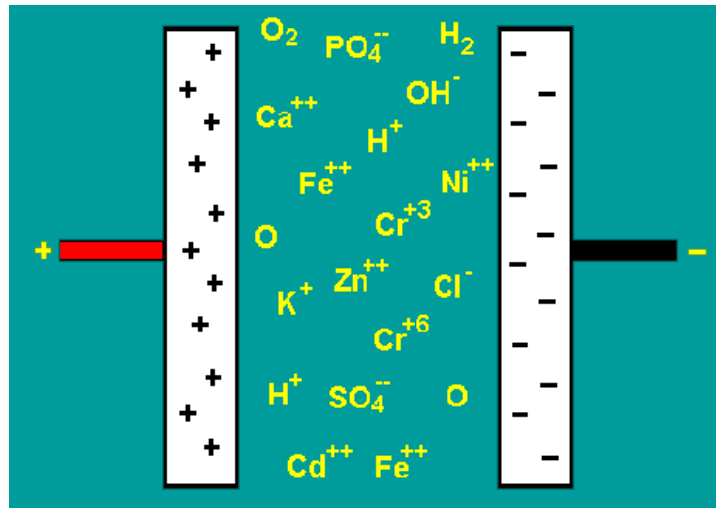
Principles of Electro Coagulation Process



Electro Coagulation – Eco Friendly

WHAT IS ELECTRO COAGULATION?

Electro coagulation is an electrochemical process that simultaneously removes heavy metals, suspended solids, emulsified organics and many other contaminants from water using electricity instead of expensive chemical reagents.



HISTORY

The principle of electro coagulation was first patented in 1906 by A. E. Dietrich and was used to treat bilge water from ships. With the relatively recent concerns about pollution, industries came under great pressure to find innovative ways to comply with environmental regulations. Electro coagulation has re-emerged as a viable technology.

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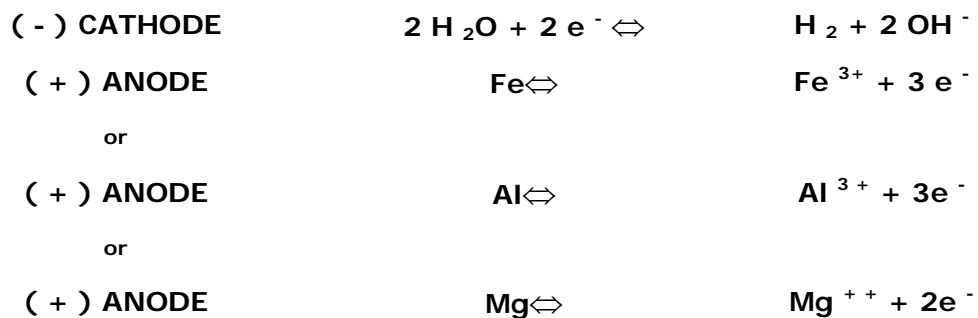
Electro Coagulation BASIC WORKING PRINCIPLE



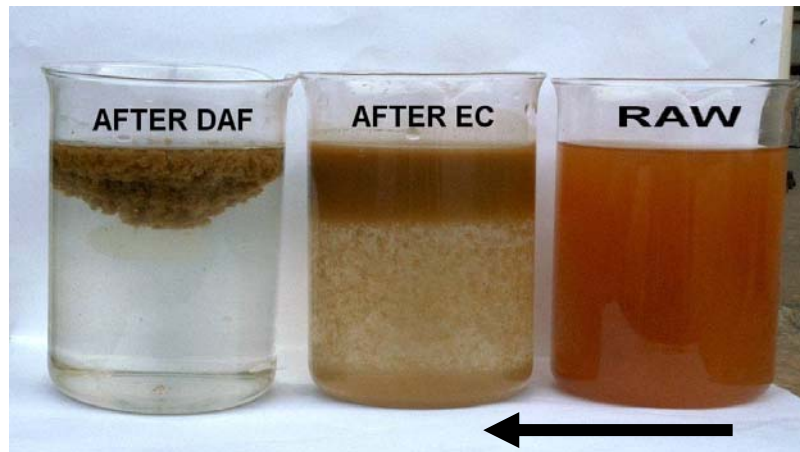
The **Electro Coagulation** system-working principle implies that a potential, being applied a water solution, may facilitate and/or accelerate oxidation-reduction processes of the solution substances. According to potentials at stake, some hydrogen or oxygen micro bubbles may develop at the cathode or at the anode.

These insoluble gases micro bubbles, whose dimensions are very reduced (<10-2 mm), tend to go up again towards the cell surface, dragging all the suspended substances, the hydrocarbons, the colloids etc, because of a specific weight difference in comparison with the liquid to be treated; in this way a treated liquid clarification is provoked already at this stage (Flotation)

If anodes are soluble, for example carried out in Aluminium, in Magnesium or in Iron, the current passage crossing them causes their dissolution according to the following reactions:

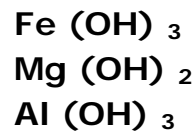
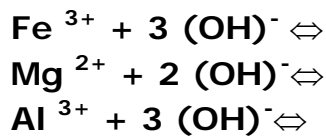


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Photographs of mixed wastes from auto-parts manufacturing plant [Electro Coagulation \(EC\)](#) and after Dissolved-Air Flotation process.

The pH into the reactor is set, at the inlet, at a value between 6,5 to < 9pH, thus obtaining the immediate formation of hydroxyls corresponding to OH-hydroxyl groups because of reaction. In addition to that, the water reduction to the cathode keeps unchanged alkalinity and allows, even after the hydroxyls precipitation, a remarkable NaOH or Ca (OH)₂ alkalisng product saving.

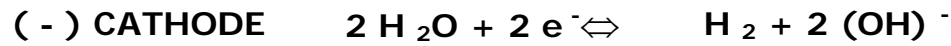


This electrochemical phenomenon is named electro-coagulation. Briefly, electrical-coagulation assures the development of hydroxyls of all the present metal ions (not only the electrodes) shown as muddy bow recovered afterwards through settlement or flotation, according to the kind of application .

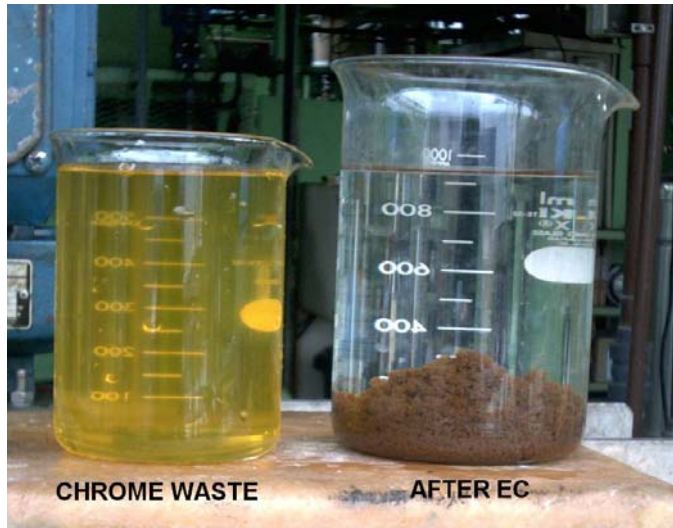
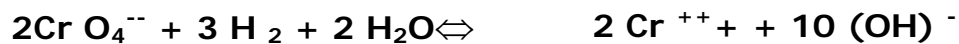
The most interesting phenomenon taking place inside the cell is water substances oxidation or reduction, concurrently with the water itself oxidation or reduction, as previously shown.

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For example, in case of a galvanic cell where an electrolytic galvanisation process, with chromic passivations, or an electrolytic chromium plating process take place, all the waters (in absence of cyanides) flow into the electrical-chemical reactor where the following reactions take place:



As a consequence, the developed hydrogen determines the following reaction:



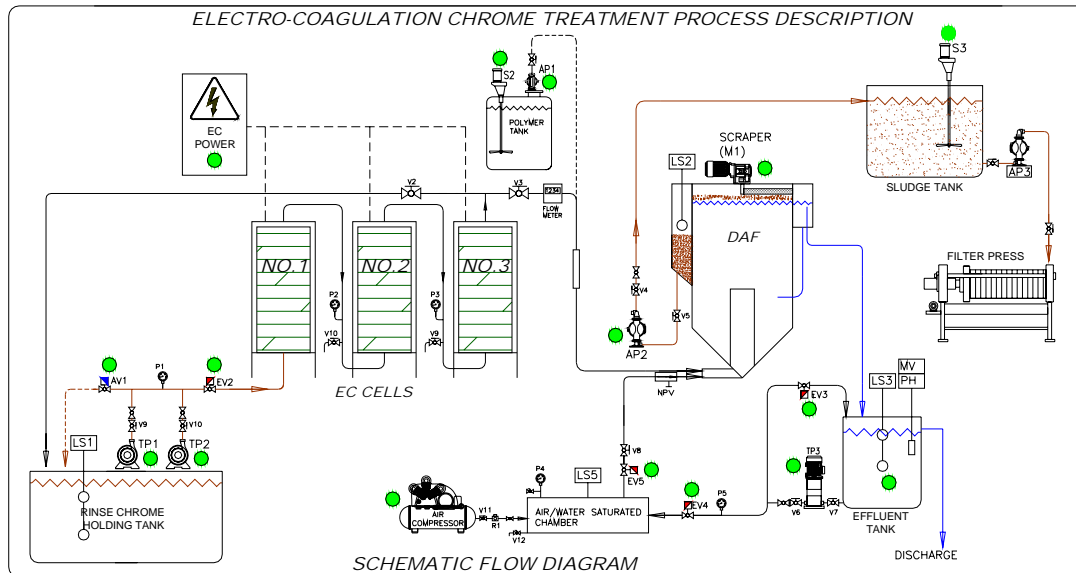
Causing the chrome reduction from hexavalent to trivalent, in an alkaline milieu without adding chemical products; therefore, in comparison with the traditional purifying systems, it allows saving Sulphuric Acid, Sodium bisulphite and Sodium hydroxide preventing from reusing the purified waters because of a salinity increase. Fe³⁺ ion dissolves, if an Iron anode is used, binding itself to hydroxyls, too, thus creating,

as it has already been stated, Iron hydroxide with a coagulating effect towards other metal hydroxides.

The system yield is hugely increased by the widespread Fe³⁺ ion presence in each part of the cell and the concurrent iron hydroxides and other metals development.

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SIMPLIFIED CHROME TREATMENT SCHEMATIC



Moreover the electrical field effect is such to cause even the ethoxylic compounds (not ionic surface-active agents) big organic molecules crushing into lower molecular weight fractions by destroying the surface-active agent as the active principle and obtaining, more generally, a C.O.D. reduction, too.

This system perfectly applies to phosphate containing liquids, too. Actually, the Fe PO_4 or Al PO_4 formation may be obtained into the [Electro Coagulation](#) reactor and then they may be eliminated during a following sedimentation stage.

The final neutralisation stage is necessary only whenever the present metals hydroxyls precipitation best possible pH value is higher than 9,5 (Cu, Ni, etc)

Filtration on active coal beds is necessary only whenever present surface-active agent and COD values are very high. The selective resin has to be considered as an OPTIONAL since it is possible to reach the values, set by the D.L. (law by decree) 152 of 11th/05/1999 "tab. 3" for the present metals, already at the outlet of the Quartzite filter.

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The above mentioned sections installation may be advisable or not, on the grounds of considerations on advisability for more safety, on certitude to maintain during the time some purification results even in the presence of special events or troubles.

In these cases, however, the final sections management cost will be extremely cut since they are used in emergency cases only.

The electrochemical treatment system, whose trade name is [Electro Coagulation](#), offers excellent results for all discharge types wherever there are mainly colloidal substances and/or suspended substances in general (for the flotation effect), wherever there is any kind of heavy metals in solution, eventual complexes metals included.

During the latest years, [Electro Coagulation](#), has carried out, directly or through importers, many plants equipped with the new treatment system for different sectors, such as:

- **GENERAL GALVANIC**
- **HOT AND ELECTROLYTE GALVANISATION**
- **VIBROFINISHING**
- **PRECIOUS METALS WORKING**
- **PRINTED CIRCUITS**
- **PHOSPHOGREASING AND PHOSPHOCHROME PLATING**
- **PRAWN & FISH FARMING**

PRAWN & FISH FARMING APPLICATION

Bacteria removal rates in excess of 99% have been achieved using [Electro Coagulation](#). The process appears to hold significant advantages for the treatment of wastewaters.

	EAT Decant	Electropure Treatments		Plus Ultra Violet Light
Faecal Coliforms	360,000 per 100 ml	94 / 100 ml	78/ 100 ml	0/ 100 ml
Turbidity		1.5 NTU	2.4 NTU	1.5 NTU
Conductivity		395 μ S/cm	508 μ S/cm	700 μ S/cm
Cryptosporidium	750/50L	12/50L	10/50L	<2/50L
Giardia	7500/50L	70/50L	55/50L	<2/50L

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FATS, OIL AND GREASE REMOVAL APPLICATIONS

Table 1 gives an indication of results achieved from grease trap water, as well as reductions in the FOG concentrations, the COD level have been reduced by over 96%.

Water Source	Pollutant	Before mg/L	After mg/L	Percent Removal
□ Grease Trap	FOG	81,440	20	99.97□
	COD	145,500	5,320	96.3□
□ Oil Trap	TOC	6,091	36.8	99.4□
	COD	16,360	763	95.3

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MAIN ADVANTAGES SYNTHESIS

- 1) Drop results generally higher of at least 25%.
- 2) Coagulating products, flocculating ones, acids and bases extremely reduced use.
- 3) Mud production is as an average 40% lower than traditional systems.
- 4) C.O.D, B.O.D and surface-active agents reduction.
- 5) Cr6+ direct elimination without installing a special reactor.
- 6) Phosphate drop without using heat.
- 7) Nitrites and Sulphites oxidation into Nitrates and Sulphates.
- 8) Management costs generally cut of 50%, as an average
- 9) Opportunity to recycle a part of treated waters.

BENEFITS

Excellent Results

Treatment levels are typically below the capabilities of conventional chemical precipitation. This makes electro coagulation the method of choice for direct dischargers or others faced with ultra-low limits.

Low Operating Costs

Operating costs can be dramatically reduced. The KASELCO process typically reduces treatment cost to \$1.00 to \$4.00 per thousand gallons of industrial wastewater.

Simultaneous Treatment

Multiple contaminants can be treated simultaneously, doing away with the necessity of segregating waste streams.

Chemical Reagent Elimination or Reduction

pH adjustment is usually not necessary. An increase in pH during the process and the lower solubility of metal oxides allows a much wider pH range than typical chemical processes. Dissolved solids levels in treated wastewater can be drastically lower than from chemical processes.

Sludge Minimization

Lower use of reagents reduces the amount of sludge produced resulting in lower disposal costs.

Sludge Stabilization

Electro coagulation usually produces a stable sludge that will pass TCLP testing. If your waste is not a listed waste, disposal costs can be significantly reduced.

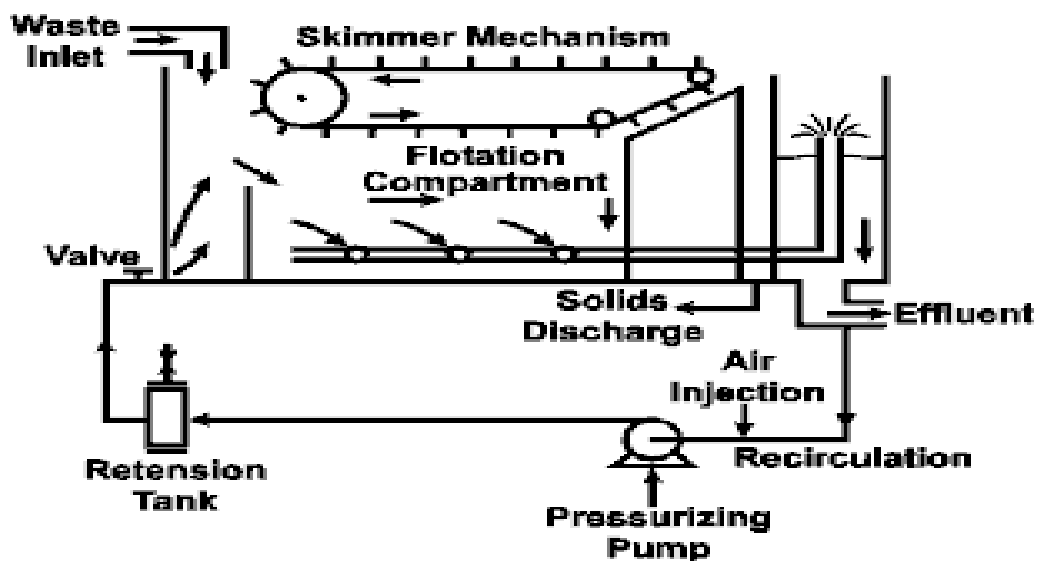
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DISSOLVED AIR FLOTATOR (DAF) WORKING PRINCIPLE

In order to use the produced hydrogen gas as a flotation medium, we needed to design the elements such that this could be achieved effectively. This has been done and the system now operates effectively as a flotation system, with most of the pollutants floating to the surface, from where they need to be removed.

The pollutants float to the surface, where they are concentrated. From there they are floated out the top by simply raising the water level by the injection of further water to the bottom of the tank. Provided this is done in a suitable manner, the water floats the pollutants from the surface causing them to overflow into a sludge container.

The water is pumped in and processed. The pollutants are removed from the top by periodically adding water from the treated effluent tank, the amount of water added being about 5% of the volume of the water being processed.



SCHEMATIC OF DISSOLVED-AIR FLOTATION

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OPERATION OF ELECTRO COAGULATION SYSTEM

Conductivity & pH

The operation of the system depends heavily upon the conductivity - which varies from between $\sim 50 \mu\text{S/cm}$ (μS) for contaminated rain water, to over 10 mS/cm (mS) for some water heavily contaminated by salts - and pH of the water. Best results were achieved with a starting pH of between 4.5 and 8. pH dosing and control is readily available so this does not represent a problem.

Variations in conductivity are handled by the design of the elements and power supply. This is done at the time of installation, from knowledge of the conductivity of the water. Once this has been set, variations in conductivity by a factor of 2 up or down can be easily accommodated by the system.

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SUMMARY OF TREATED WATERS, WASTE STREAMS, AND LIQUID



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Certificate Of Analysis



ISO/IEC 17025
TESTING
SMM NO. 076

Company : Nikojati Sdn.Bhd.
Registration No. : BL0308CNJ-0136
Sampling Point : 1. W1 : Raw dated on 15/08/2003
2. W2 : Treated after EC dated on 15/08/2003
3. W3 : After carbon dated on 15/08/2003
Receiving Date : 18/08/2003
Reporting Date : 03/09/2003

Chemicals analysis results for the above submitted wastewater samples are tabulated as follows:

Parameters	Units	Results		Standard B	Method Used
		W1	W2		
1. pH value (tested on 20/08/2003)	-	10.0	9.9	5.5 -9.0	APHA 4500 H ⁺ B, 1995
2. Biochemical Oxygen Demand @ 5 days at 20°C (tested on 20/08/2003)	mg/l	968	254	50	} APHA 5210 B, 1995 } APHA 4500 O-G, 1995
3. Chemical Oxygen Demand	mg/l	10104 (tested on 19/8/03)	1638 (tested on 20/8/03)	100	
4. Total Suspended Solids	mg/l	1880 (tested on 19/8/03)	222 (tested on 25/8/03)	100	APHA 2540 D, 1995
5. Mercury as Hg	mg/l	<0.001	-	0.05	US EPA Method 245.1, 1991
6. Cadmium as Cd	mg/l	0.07	0.06	0.02	APHA 3111 B, 1995
7. Chromium Hexavalent as Cr ⁶⁺	mg/l	<0.01	-	0.05	APHA 3500-Cr D, 1995
8. Arsenic as As	mg/l	<0.01	-	0.10	PE:B3505 : As(1994)
9. Cyanide as CN	mg/l	<0.02	-	0.10	APHA 4500 CN C&F, 1995
10. Lead as Pb	mg/l	189.80	0.80	0.5	APHA 3111 B, 1995
11. Chromium Trivalent as Cr ³⁺	mg/l	4.10	0.38	1.0	APHA 3111 B, 1995
12. Copper as Cu	mg/l	12.21	0.17	1.0	APHA 3111 B, 1995
13. Manganese as Mn	mg/l	1.32	0.14	1.0	APHA 3111 B, 1995
14. Nickel as Ni	mg/l	5.52	0.51	1.0	APHA 3111 B, 1995
15. Tin as Sn	mg/l	<0.004	-	1.0	PE: B 3505 : Sn (1994)
16. Zinc as Zn	mg/l	1060.00	2.92	2.0	APHA 3111 B, 1995
17. Boron as B	mg/l	0.5	-	4.0	ISO (9390 : 1990E)
18. Iron as Fe	mg/l	77.33	1.49	5.0	APHA 3111 B, 1995
19. Phenol	mg/l	<0.1	-	1.0	APHA 5530 B&D, 1995
20. Free Chlorine as Cl ₂ (tested on 20/08/2003)	mg/l	<0.1	-	2.0	In House Method Based on BS 1427, 1962
21. Sulfide as S ²⁻	mg/l	2230.0	238.8	0.50	APHA 4500 S ²⁻ F, 1995
22. Oil and Grease (tested on 19/08/2003)	mg/l	ND(<2)	-	10.0	APHA 5520 B, 1995

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(Lab Manager)

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CONTAMINANT REMOVED	PPM BEFORE TREATMENT	PPM AFTER TREATMENT
Chlorinated Hydrocarbons Land Fill Leachate	340	13.00
Cyanide, Total	62	0.06
Oily Cooling Waters	1,500	38.00
Food, Oils & Water	25,000	4.00
Animal Fats	5,700	90.00
Rendering	4,200	54.00
Cooking Fats	18,000	86.00
Nitrates	500	54.00
Fabric Dyes	180,000	4.00
Paracresol Methyl Ether	1,000	41.00
Methyl Dihal	2,200	36.00
BOD's Chicken Processing	1,000	248.00
BOD's Tanker Wash Out	96,000	150.00
Oil & Grease (Chicken)	1,300	2.50
Refinery Discharge Waters:		
KO 49-52 Crude Oil Waste	80,000	<5.0
Bottom Sediment	120,000	<3.0
Rain Run Off Oil	30,000	<5.0

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Contaminant Removed	Source of Water	PPM Before Treatment	PPM After Treatment
Arsenic	Mining	52	.005
	Chemical Mfg.	900	.125
Barium	Battery Mfg.	30	<.050
Calcium	Boiler	1,230	6.000
Chrome	Manufacturing	46	.040
	Plating	900	<.003
Copper	Dry Cell Battery	90	<.003
Gold	Mining	4	N/D
	Plating	6	N/D
Iron	Wells	106	N/D
Lead	Automotive Battery	90	<.005
Magnesium	Mining	65	<.003
Manganese	Manufacturing	3	2.000
Mercury	Cosmetics Plant	12,000	N/D
Nickel	Plating	43	.300
Selenium	Mining	1	.060
Silicon	Manufacturing	52	N/D
Silver	Mining	5	.030
Sulfur	Crude Oil	5,000	N/D
Tin	Plating	50	.080
	Manufacturing	43	.006
Zinc	Land Fill Leachate	46	.020
	Plating	80	.008

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Electro Coagulation References

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