Prayon 3-crystal Process for Phosphoric Acid Production

PEP Review 2026-10

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Glossary

°C	Degrees Celsius
°F	Degrees Fahrenheit
¢/lb	Cents per pound
$/t	Dollars per metric ton
%	Percentage
ACFM	Actual cubic feet per minute
atm	Atmosphere(s)
bhp	Brake horsepower
BFD	Block flow diagram
BLI	Battery limits investment
BPL	Bone phosphate of lime
Btu	British thermal unit(s)
CAPEX	Capital expenditure
cf/ft^3	Cubic feet
cP	Centipoise
CPP	Central-Prayon Process
CS	Carbon steel
DAP	Diammonium phosphates
DH	Di-hydrate
EV	Electric vehicle
FOB	Free/freight on board
FRP	Fiberglass-reinforced plastic
ft	Feet
ft^2	Square feet
g	Gram(s)
G&A	General and administrative
gpm	Gallons per minute
h	Hour(s)
HH	Hemi-hydrate
HDH	Hemi-Di-Hemi
HH-DH	Hemihydrate-dihydrate
HVAC	Heating, ventilation, and air conditioning
ISBL	Inside battery limits
kCal	Kilocalorie(s)
kg	Kilogram(s)
kJ	Kilojoule(s)
kPa	Kilopascal(s)
LFP	Lithium iron phosphate
LMFP	Lithium manganese iron phosphate
LP	Low-pressure
MAP	Monoammonium phosphates
Mgal	Thousand gallons
Mlb	Thousand pounds
MMBtu	Million British thermal units
MMt	Million metric tons
MMt/y	Million metric tons per year
MOC	Material of construction
mol%	Molar percent
mPa	Megapascal(s)
MP	Medium-pressure
OPEX	Operating expenditure
OSBL	Outside battery limits
P	Phosphorus
PEP	Process Economics Program
PFD	Process flow diagram

pH	Potential of hydrogen
ppm	Parts per million (volume basis)
psia	Pounds per square inch absolute
psig	Pounds per square inch gauge
POP	Plaster of paris
ROI	Return on investment
rpm	Revolutions per minute
s	Second(s)
SBR	Styrene butadiene rubber
scf	Standard cubic feet
scm	Standard cubic meter(s)
SPA	Super phosphoric acid
SS	Stainless steel
t	Metric ton(s)
t/d	Metric tons per day
TFC	Total fixed capital
t/h	Metric tons per hour
t/y	Metric tons per year
UOM	Unit of measurement
USGC	United States Gulf Coast
vol%	Volume percent
w/w	Weight by weight
wt%	Weight percentage

Abstract

Phosphoric acid (H_3PO_4) is the most important oxyacid of phosphorus (P) and is primarily used for production of phosphate fertilizer products like ammonium phosphates and triple superphosphate. It is also used in dental cements, in the preparation of albumin derivatives, in sugar and textile industries, and for pH control in food industries like cheese products, fats, shortening and soft drinks [1], [2]. Fertilizer production accounts for more than 80% of the global market for phosphoric acid, with animal feed accounting for about 5%. The remainder is consumed in a variety of industrial applications [CEH-Phosphoric Acid].

The fastest growing market for phosphoric consumption is in lithium iron phosphate (LFP) and lithium manganese iron phosphate (LMFP) batteries that are used in electric vehicles (EVs), particularly in mainland China, with a projected annual growth rate of 15%-20% till 2029. Traditional markets for H_3PO_4 are fairly mature on a global level and are expected to grow at less than 1% annually. On a volume basis, production of diammonium phosphates (DAP) has the largest influence on global phosphoric acid growth rates, accounting for about one-third of global consumption, followed by monoammonium phosphates (MAP) [CEH-Phosphoric Acid].

In 2023–24, significant capacity reductions occurred in Central and Eastern Europe; however, this was offset by more capacity expansion in Africa, mainland China, Kazakhstan, and Russia. Also, in the next five years a few million metric tons of new capacity expansion is further expected in the Middle East, India, Oceania, and Central and South America.

In the Process Economics Program (PEP), not much work has been done in recent years on phosphoric acid production technologies. The latest PEP report from the phosphoric acid series PEP reports (RP-08C) was published in August 1982, covering the process economics for di-hydrate, hemihydrate-dihydrate, and hemi-hydrate processes, while PEP review 1992-03-02 covered the economics for phosphoric acid production from thermal process, and its purification to technical- and food-grade phosphoric acid products. The phosphoric acid plant also produces large quantities of gypsum (4.5 to 6 tons per ton of P_2O_5 production), which has limited applications. PEP review 1986-02-02 covered gypsum utilization for production of sulfuric acid and aggregate and construction applications using the DMC-FIPR process, a joint venture between Davy McKee Corp. and Florida Institute of Phosphate Research. PEP review 2025-09 covered the Prayon Hemihydrate-Dihydrate (HH-DH) process, “PH2 process,” while this review extends RW2025-09’s work and covers the Prayon 3-crystal process (PH3) for phosphoric acid production with a capacity of 1,200 t/d (on 100% P_2O_5 basis) at a US Gulf Coast (USGC) location.

An iPEP Navigator tool is also attached with the electronic version of this review. The interactive iPEP Navigator process optimization module provides an economic snapshot for the process, allowing the user to select and compare processes, units, and regions of interest.

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