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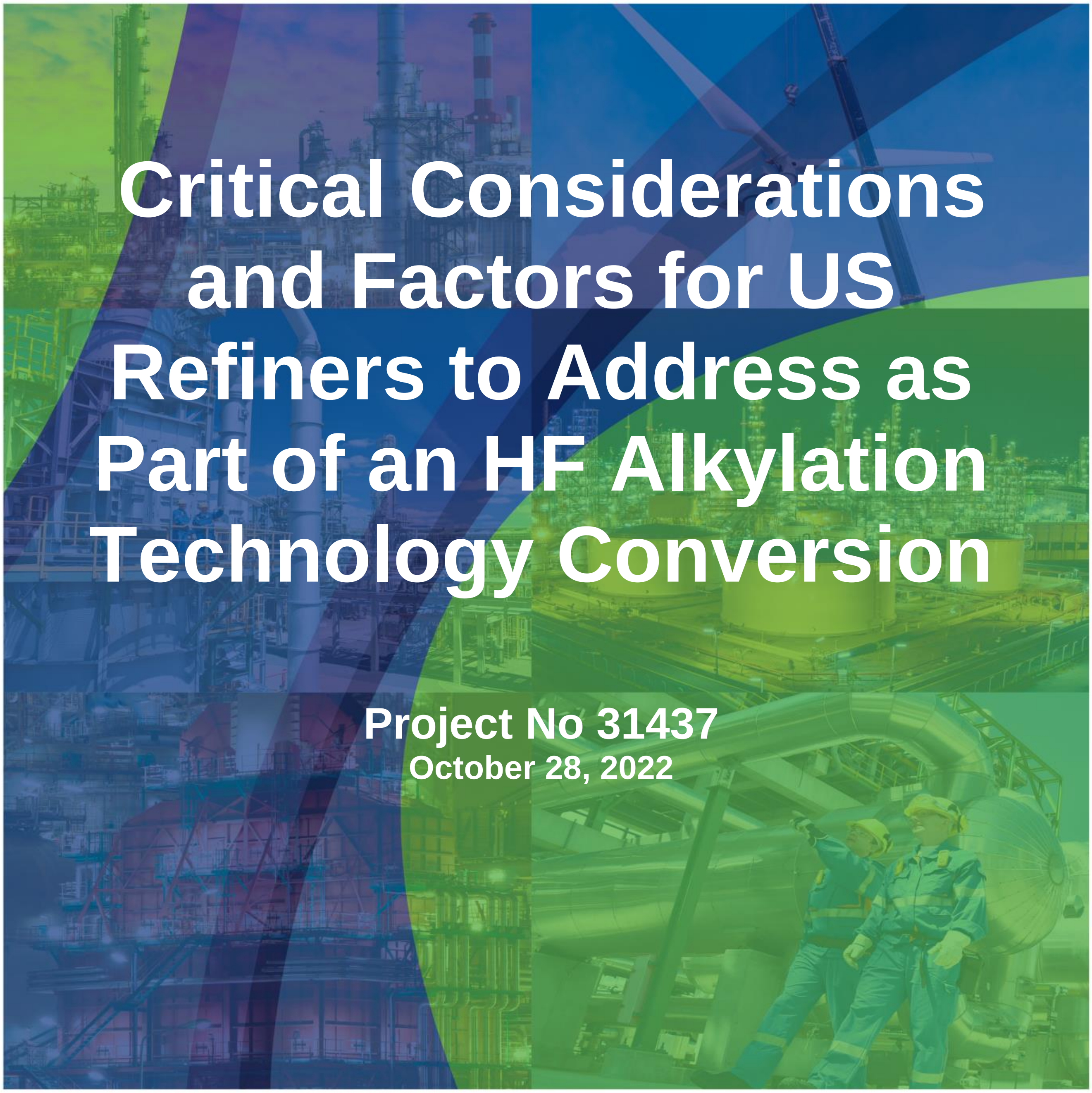
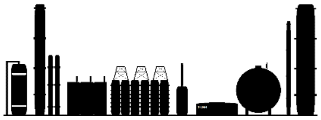


# Critical Considerations and Factors for US Refiners to Address as Part of an HF Alkylation Technology Conversion

**Project No 31437**

**October 28, 2022**



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## 1. Introduction

Alkylation is a critical process in refinery operations to produce gasoline that meets modern clean fuel and engine performance requirements. The use of one specific alkylation catalyst, hydrofluoric acid (HF), has received considerable public and regulatory scrutiny. This paper discusses various potential impacts of requiring HF alkylation units operating within the US to be shut down and dismantled.

Two primary catalyst technologies exist for alkylation: HF alkylation and sulfuric acid alkylation. Each technology currently accounts for about half of US alkylate production. Refiners generally chose one technology over the other based on a variety of considerations, including location, plot space, and differences in the ability of these two technologies to process certain feedstocks.

Refineries must find an economic use for every product produced on site. An alkylation unit consumes primarily light olefins (propene and butenes) and isobutane produced by the fluid catalytic cracking (FCC) unit and secondarily light olefins produced by the coker unit. Another possible destination for light olefins is the petrochemicals industry. An alkylation unit is the only economically viable destination for isobutane produced by refineries. Directing isobutane to an ethylene cracker or a dehydrogenation and poly gas complex would not make economic sense. Thus, for refineries with an alkylation unit, the FCC and alkylation units are linked together to the extent that shutting down either process is likely to shut down both.

## 2. Risk & Safety

The refining industry can and does safely manage the risk of HF in the alkylation process. The industry adheres to API Recommended Practice (RP) 751, the most rigorous and comprehensive document pertaining to the safe operation of HF alkylation units. The purpose of API RP 751— Safe Operation of Hydrofluoric Acid Alkylation Units—is to communicate and support proven industry practices and keep refinery employees, community neighbors, and their surrounding environment safe. In 2021, RP 751 was updated to its fifth edition and is used globally. After the implementation of each edition, the number of release incidents typically trends downward demonstrating the effectiveness of RP 751 when it is broadly applied across industry:

## 3. Potential Courses of Action from an HF Alkylation Ban

If HF alkylation units are required to shutter, refineries would be faced with one of three options:

- Rebuild a different alkylation technology
- Shut down the HF alkylation and FCC units and sell the FCC unit feed
- Shut down the refinery

Only the first of these options, rebuilding to use a different alkylation technology, limits the potential impact to the US gasoline pool.

The second option would result in both less gasoline production and less capacity to make certain high value blends of gasoline (e.g., reformulated gasoline for the California market and high-octane gasoline blends). The other factor that must be considered for option two is that US refineries with HF alkylation units consume considerable FCC unit feed and only certain parts of the US (Primarily those with heavy petrochemical industry presence) are capable of selling that feed on the open market. Further, the local open market would likely only be able to absorb a portion of that feed, making this option marginal at best. For refineries with both alkylation and FCC units, the total of FCC gasoline plus alkylate makes up approximately 60 vol% of the gasoline pool. Since about half of US alkylation capacity is from HF Alkylation units, shutting down both the FCC and HF Alkylation units would reduce the US gasoline pool. Finished gasoline for US consumption is a combination of FCC gasoline, reformate, alkylate, isomerate, butane, virgin naphtha, poly gasoline, and ethanol.

The third option, refinery shutdowns, would drive the biggest reduction to total US gasoline supplies.

When considering alkylation technologies beyond HF, three options are often discussed, though only one has undergone sufficient commercial testing and broad scale adoption:

- Sulfuric acid alkylation technology (sulfuric acid catalyst is widely used and accounts for about 50% of US alkylate production)
- Ionic Liquids alkylation technology (undergoing commercial testing at one US refinery)
- Solid Catalyst alkylation technology (undergoing commercial testing outside the US)

Of these three, sulfuric acid alkylation technology is by far the most prominent, with on the order of 100 units operating in the world (about half of which are in the US). Ionic Liquids alkylation currently has < 10 units operating in the world (one of which is in the US being commercially tested). Two units operating in China using Solid Catalyst alkylation technology (neither of which a is in the US). Both Ionic Liquids and Solid Catalyst alkylation technologies are relatively new (< 20 years old) compared to HF and sulfuric acid alkylation (> 75 years old). There simply isn't enough commercial history or completed testing at this point to recommend technologies beyond HF and sulfuric acid for broader adoption. Therefore, if refineries were required to shut down HF alkylation capacity, many would consider sulfuric acid alkylation technology the only commercially proven alternative technology.

The cost to conduct an Inherently Safer Technology (IST) or Safer Technology Alternative Assessment (STAA) to the standards of the Environmental Protection Agency (EPA) would range from $360 to 1,000 million per facility (Table 2: Summary).

## 4. Cost Considerations for Transition Away from HF Units

The technology differences between HF and sulfuric acid alkylation units would require the removal of the existing HF alkylation unit and the construction of a replacement unit (excluding catalyst regeneration). If 100% of existing HF alkylation unit capacity is replaced with sulfuric acid alkylation capacity**, the total installed cost (TIC) for the new sulfuric acid alkylation capacity at all 41 US refineries that currently have HF alkylation units would be $15 to 41 billion, excluding unforeseen inflationary**

**pressure**. These costs are in addition to alternative technology assessments, per direction from the Environmental Protection Agency (EPA) (Appendix 1: Safer Technology Alternative Assessment); costs to decontaminate, deconstruct and decommission existing HF units (Appendix 3: HF Decommissioning Costs); and costs to manage spent sulfuric acid, whether by constructing an acid regeneration unit onsite or paying for offsite regeneration (Appendix 2: Sulfuric Acid Regeneration TIC), including transportation to and from those sites.

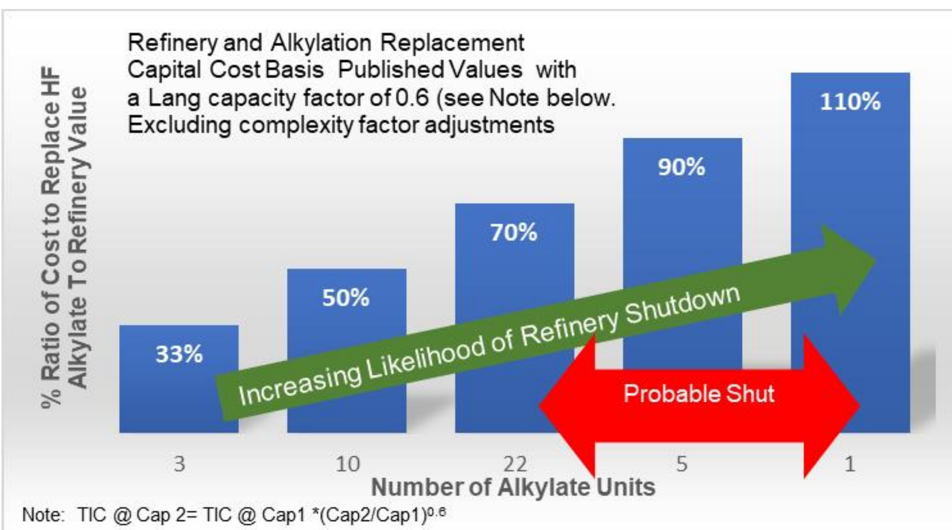
For individual facilities, the TIC (in 2021 US dollars) to replace an HF alkylation unit with a sulfuric acid alkylation would range from **$200 to 850 million per facility depending on the size of the unit**, but not including either recent cost escalation or Outside of Battery Limits (OSBL) impacts (Sections 15-16). For some facilities, the cost would be too much. To provide perspective:

- PBF purchased the ExxonMobil Torrance refinery for $538 million in 2016 (adjusted to $590 million in 2022 dollars)
- BP Toledo recently sold its 50% refinery interest to Cenovus for $300 million, giving the refinery a total value of $600 million

These two examples illustrate the current level of refinery value.

To ascertain the economics of an alkylation replacement project the TIC to replace a site's HF alkylation unit with a sulfuric acid alkylation unit is calculated as a percentage of the current refinery value. For example, if the TIC to build a new sulfuric acid alkylation unit is $250 million and the purchase value of the refinery is $500 million, the project cost would be 50% of the refiner total value. For the US refineries currently operating with HF alkylation units, the TIC/Refinery percentages rage from 30% to 110% as shown in Figure 1 below:

**Figure 1: Cost to Adopt Sulfuric Acid Alkylation Compared to Refinery Value**



As the percentage increases, the likelihood decreases of constructing a sulfuric acid alkylation unit in its place. Any of the following might be basis for a refinery shutdown:

- High cost of a new alkylation unit relative to refinery value
- Inability to find alternative markets for a refinery's light olefins and isobutane, which would force a throttling of refinery production or a total shuttering
- Cutback or shutdown of the FCC unit to limit light olefin and isobutane outputs resulting in loss of profitability
- Inability to add a new alkylation unit due to an insurmountable constraint (e.g., lack of plot space)
- Inability to obtain an operating permit for a new alkylation unit

It is estimated that four to nine refineries would shut down rather than either build a new alkylation unit or attempt to operate with both their HF alkylation and FCC units shut down. The refineries that would likely close are distributed around the country, have a total crude run of about 700,000 BPCD and gasoline accounts for 50 % of their output.

## 5. HF Alkylation Shutdown Decommissioning Cost

In all instances where the HF alkylation unit is shutdown, the unit requires decontamination and demolition. A cost estimate was prepared including processing of the hazardous waste produced. For an average HF alkylation unit, the demolition cost was estimated at $30 million +/- 50%. This is a cost borne by the refinery, is not dependent on the choice to continue to operate or not, will increase the cost of producing gasoline, and is not included in the TIC to replace the HF alkylation unit with another technology. The estimate was based on a 20,000 BPD HF alkylation unit (see Section 16). For the 40+ HF alkylation unit in the US, this is a total of about $1.2 billion in additional costs.

## 6. Sulfuric Acid Transportation and Regeneration

A key factor in the decision to replace HF alkylation assets with sulfuric acid alkylation assets is the availability and transport of the acid. Sulfuric acid alkylation uses approximately 200 times more acid than HF alkylation and requires storage tanks for both fresh and spent acid. An option exists to design, construct, and operate a sulfuric acid regeneration facility at the refinery site or offsite. The TIC for a unit able to process the spent sulfuric acid from a 20,000 bpd sulfuric acid alkylation unit is estimated at $131 million (Appendix 2: Sulfuric Acid Regeneration TIC). If a refinery were to adopt this option, it would be an additional capital cost. Sulfuric acid plants do not resemble other refinery units, so most refineries that switch to sulfuric acid alkylation would likely choose to contract with a sulfuric acid producer/supplier. If this happens and the acid is transported to the regeneration site via truck, about 500 trucks per month for moving fresh and spent acid would be required. Depending on the distance to and from the regeneration facility, this can be a significant community safety risk, especially for spent acid due to its sulfur dioxide ($SO_2$) content. $SO_2$ is a toxic chemical.

## 7. Import Requirements and Energy Security

Depending upon location, shutting down HF alkylation units without replacement would increase US reliance on imported fuels/gasoline blending components. This is already the case for much of PADD 1, where in 2021, 576,000 BPCD of gasoline blending components and 80,000 BPCD of finished gasoline were imported. To convey potential volumes that may need to be replaced with additional imports, consider that US refineries with HF alkylation capacity represent a total crude processing capacity of 6.5 to 7.0 MMBPD. If 10% of this rate is shut down and not replaced, 650,000 to 700,000 BPCD of refinery crude capacity would be affected. Gasoline is the number one product produced by these refineries, accounting for approximately 50% or 390,000 to 420,000 BPCD of total product outputs. This relatively small reduction in total US gasoline supply (4.4 to 4.8 % of 8.8 MMBPD) would likely increase prices at the pump.

## 8. Capital Investment Differences Between HF and Sulfuric Acid Units

Another component of the refinery shutdown option is that sulfuric acid units are more expensive than HF units to construct, approximately a 5-10% higher TIC. Thus, outside the US HF alkylation capacity could be built at lower cost than constructing new sulfuric units in the US. This would give foreign competition a cost advantage. Refinery shutdowns would also erode US market position, reduce US competitive advantage, and reduce US energy independence and therefore US energy security.

## 9. Sourcing Alkylate from the Global Market

Another group of refineries would likely attempt to operate with both the FCC and HF Alkylation units shut down and find alternative dispositions for FCC unit feed. Refiners on or near the US gulf coast would likely explore this option, so essentially a fraction of PADD 3. The other part of this option is to purchase alkylate as necessary to meet fuel blend specifications. Alkylate is known as the ideal gasoline blending component due to having low RVP, good octane (both MON and RON), is generally < 5 ppm in Sulfur, contains no aromatics, and contains no olefins. The assumption is purchased alkylate can reach the gulf coast by ship. The author’s estimate of alkylate market price using a historical value range is between $130 and $150/BBL given current alkylate supply/demand balances.

A key unknown for this option is the extent to which FCC feed can be absorbed into the system. It can currently take in FCC unit feed when maintenance outages are performed on these units for refineries that have either HF or sulfuric acid alkylation units and are located in the US gulf coast region of PADD 3. These outages, however, are spaced out in time, have finite durations, and simultaneous outages between different refineries is generally minimized due to economic impact. Permanent shutdown of the FCC and HF alkylation units would likely erode refinery profitability to the extent that operating without them is not justified even if FCC feed can be absorbed into the system.

## 10. Unequal Burdens Across Industry

The final group of refineries would invest in an alternate alkylation technology and continue to make alkylate, with costs as discussed previously. For this case, timing of startup of new alkylation assets versus shutdown of existing HF alkylation assets could play a role in US impacts, especially if there is a substantial time gap between them. For example, this could be the case if the only plot space for a new alkylation unit is the existing HF alkylation unit. In this case, the duration between shutting down the existing HF alkylation unit and starting up an alkylation unit that uses different technology would be on the order of 3 years.

A key note is that the penalty for banning HF alkylation would be paid by refiners that use this technology, and some US refiners own several HF alkylation units. As a result, the US refiners that own HF alkylation assets would be adversely impacted where sulfuric acid and alternative alkylation refineries would not.

## 11. PADD Impacts for HF Alkylation Shutdowns

Table 1 shows the current total alkylate production by PADD and Figure 2 is the US PADD map.

| PADD | 1 | 2 | 3 | 4 | 5 | Total | % |
|---|---|---|---|---|---|---|---|
| | Rate MBPCD | | | | | | |
| H2SO4 | 30 | 90 | 240 | 20 | 170 | 550 | 52 |
| HF | 10 | 160 | 260 | 20 | 50 | 500 | 47 |
| Ionic | | | | 5 | | 5 | <1 |
| Total | 40 | 250 | 500 | 45 | 220 | 1,055 | 100 |

**Table 1: US 2021 Alkylation Capacity by PADD**

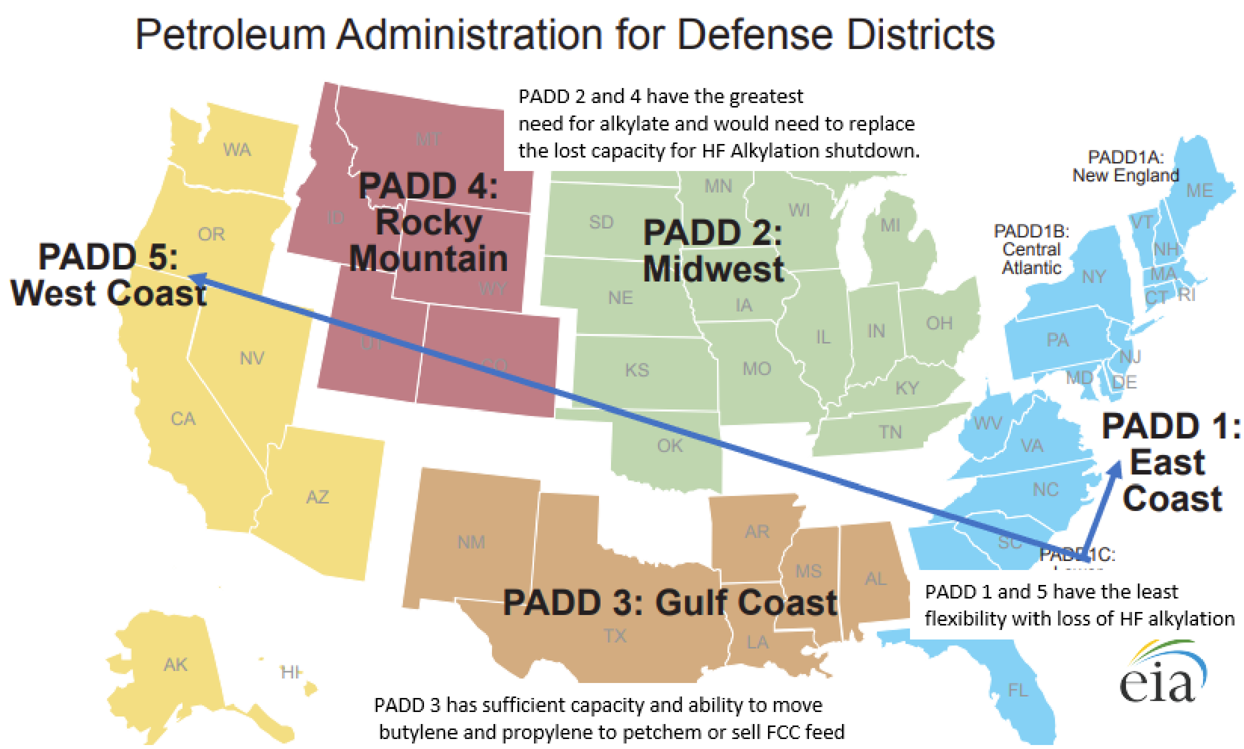



**Figure 2: PADD Map**

Per Table 1, each PADD has its own distribution of alkylation technologies. Figure 3 provides this information in a visual manner.

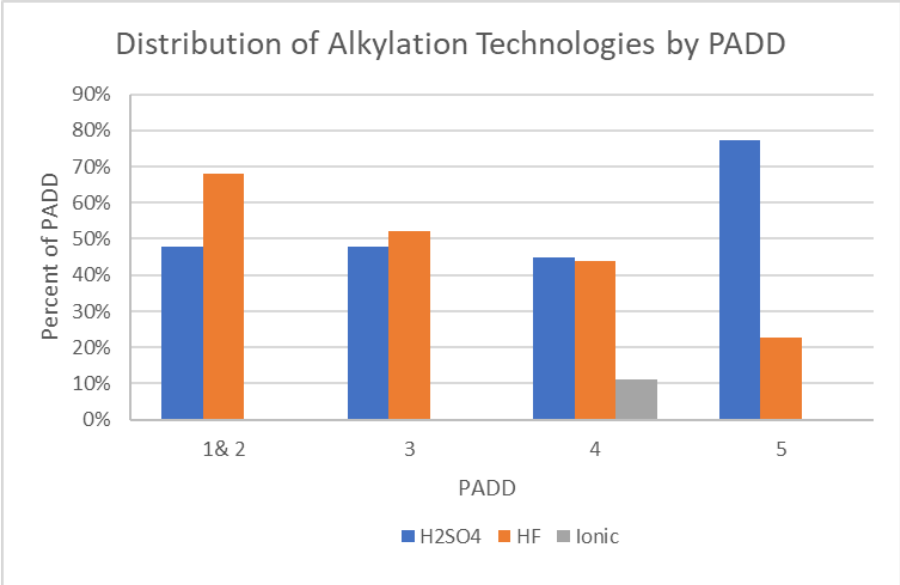



**Figure 3: Distribution of Alkylation Technology by PADD**

Some conclusions based on Table 1, Figure 3, and previous discussion are as follows:

- PADDs 1 and PADD 5 have the least flexibility to replace lost alkylate to maintain gasoline production due to shutting down HF alkylation units. It is therefore also less flexibility for loss of other gasoline blending components, which are likely a total of between 45,000 and 90,000 BPCD. This adds up to 55,000 to100,000 BPCD in total gasoline loss versus the current import rate of blending components plus finished gasoline of 656,000 BPCD in this region and a total gasoline demand of 1,500,000 to 1,700,000 BPCD in these regions.

  While PADD 5 has the largest number of alternatives to gasoline production for the light olefins, the lack of disposition economic alternatives for the contained isobutane in alkylation unit feed would force this region to either shut down refineries or build new non-HF alkylation capacity. The need for reformulated and CARB gasoline in portions of this PADD would likely drive the economics toward replacement of alkylation assets.

- PADDs 2 and 4 would both need long distance transportation of FCC unit feed out of the region and a combination of gasoline blending components and finished gasoline into the region if FCC and HF alkylation units are shut down. This does not seem likely. Therefore, these refineries are more likely to either completely shut down or install non-HF alkylation capacity. PADD 2 is more likely to switch to non-HF alkylation technology than shut down due to the need and therefore the economics to meet demand for reformulated gasoline in the Chicago and Milwaukee areas. PADD 4 is also more likely to switch to non-HF alkylation technology, but only to maintain gasoline blending capability.

- While PADD 3 has the ability to absorb both alkylation unit feed and FCC unit feed on a time-limited basis, the ability to do so on a permanent basis is unknown. In addition, permanently shutting down the FCC and HF alkylation units drastically changes refinery economics. Therefore, this PADD is most likely to install non-HF alkylation capacity or shut down the refinery.

## 12. Conclusion

The proposition of shuttering the HF alkylation units would come with significant costs to US refiners, refinery-dependent economies, fuel supplies and consumers. Importantly, the potential safety benefits of transitioning to other catalysts are unfounded and do not outweigh these costs:

1. The shuttering of HF alkylation technology and replacement with sulfuric acid alkylation does not change the risk profile, it simply introduces new risks at refineries and other points along the supply chain.
2. The cost of replacement for the shuttered HF alkylation units with the alternate technology sulfuric acid is money spent without improving the public safety.

| Name | UOM | Low | High | Comments |
|---|---|---|---|---|
| STAA Report | $ Millions | $1 | $2 | Depends on unit size |
| TIC per facility | $ Millions | $200 | $850 | Depends on unit size |
| Decontamination | $ Millions | $30 | | Cost for cleanup tear down and hazardous waste disposal |
| Spent Acid Regeneration | $ Millions | $131 | | Sized for a 20,000 BPD alkylation unit |
| Total | $ Millions | $362 | $1,013 | All inclusive |

**Table 2: Summary**

3. HF alkylation provides a substantial quantity of the US gasoline supply and removing HF units from service will negatively impact gasoline supplies.
4. For sites that decide to not replace their HF alkylation assets with another alkylation technology but instead to shut down, the local work forces would be negatively impacted.

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# 14. Appendix 1: Safer Technology Alternative Assessment (STAA)

| | | Timing | | Owners Costs | | Commercial Requirements | | Comments |
|---|---|---|---|---|---|---|---|---|
| Scope Item | Work Item | Start | End | Min $ thousands | Min $ thousands | Min $ thousands | Min $ thousands | |
| 2.1 | Requirements to Decommission, Remove Existing HF Unit and Site Remediation | To Be Determined | | $5 | $10 | $50 | $100 | Site visit and development of decon and decommisioning plan |
| 2.2 | Technology Assessment | | | $100 | $250 | $50 | $100 | Organizing and providing management guidance. Owner cost is for the ongoing oversite for the duration of the project |
| 2.2.1 | Phase1: Screening Assessment | | | $10 | $20 | $250 | $300 | Evaluation of the technology options available to replace the HF unit. Organizing licensor proposals and then developing a common base for review |
| 2.2.2 | Phase 2: Technology Selection | | | $10 | $20 | $200 | $300 | Technical, economics, risk and other considerations to allow technology selection. Ongoing owner discussions to suport the selection is at a working level then escilated to management review |
| 2.3 | Assessment concepts for each Phase | | | | | | | |
| 2.4 | Integration of the new technology into the existing refinery. | | | $10 | $20 | $50 | $100 | Understanding the impact to the refinery operation as a whole is desirable to provide the economic evaluation is section 2.1 |
| 2.5 | Reuse any of the existing assets | | | | | | | |
| 2.6 | Process Flow Diagram showing the new technology | | | | | | | |
| 2.7 | Constructability considerations | | | $5 | $5 | $10 | $10 | Build upon the decon plan if same site. Site trip to evalutate new location. |
| 2.8 | Capital Cost | | | $10 | $20 | $150 | $200 | Owners cost is to provide site support for the cost estimate. The capital cost includes site specific items and licensor costs. |
| 2.8.1 | Material cost projections | | | | | | | |
| 2.8.2 | Manpower future considerations | | | | | | | |
| 2.8.3 | Location factors | | | | | | | |
| 2.9 | Operating Costs | | | | | | | |
| 2.9.1 | Catalyst and Chemicals | | | | | | | |
| 2.9.2 | Operating Staff | | | | | | | |
| 2.9.3 | Maintenance Costs | | | | | | | |
| 2.1 | Economic Evaluation | | | $10 | $20 | $50 | $100 | Provide case study analysis and economic comparisons |
| 2.10.1 | Market future pricing | | | | | | | |
| 2.10.2 | NPV | | | | | | | |
| 2.11 | Risk Evaluation | | | | | | | |
| 2.11.1 | Technological | | | | | | | |
| 2.11.2 | Economic | | | | | | | |
| 2.11.3 | Environmental | | | | | | | |
| 2.11.4 | Health and Safety | | | | | | | |
| 2.11.5 | Reliability | | | | | | | |
| 2.12 | OSBL Considerations Including Utility Balance | | | | | | | |
| 6 | Commercial | | | $160 | $365 | $810 | $1,210 | Cost for the study |

Becht 31437 AFPM Technology Assessme

# 15. Appendix 2: Sulfuric Acid Regeneration TIC

**Table 3: Sulfuric Acid Regeneration TIC**

**Aspen Capital Cost Estimator**

**Project Cost Summary**

| | | | | | |
|---|---|---|---|---|---|
| *Project Title:* | E113.00 ACID REGENERATION | | | | |
| *Project Name:* | HF ALKYLATION | | *Scenario Name:* | E113_00 ACID REGENERATION 20220908 | |
| *Proj. Location:* | USA | | *Job No:* | | *Prep. By:* H WELKER |
| *Excel Run Date* | 8SEP22 15:09:34 | V12 | *Est. Class:* | Class 4 | *Currency:* DOLLARS USD |

| Account | MH | Wage Rate | Labor Cost | Matl Cost | Total Cost | Percentages | |
|---|---|---|---|---|---|---|---|
| (2) Equipment | 13,558 | 116.92 | 1,585,216 | 29,588,988 | 31,174,204 | 45.1% | of TDC |
| (3) Piping | 82,778 | 125.85 | 10,417,380 | 7,244,393 | 17,661,773 | 25.5% | of TDC |
| (4) Civil | 58,068 | 93.59 | 5,434,834 | 1,985,971 | 7,420,805 | 10.7% | of TDC |
| (5) Steel | 6,071 | 103.18 | 626,376 | 1,015,588 | 1,641,964 | 2.4% | of TDC |
| (6) Instruments | 18,252 | 126.28 | 2,304,807 | 2,452,929 | 4,757,736 | 6.9% | of TDC |
| (7) Electrical | 15,146 | 114.63 | 1,736,167 | 1,512,948 | 3,249,115 | 4.7% | of TDC |
| (8) Insulation | 25,478 | 98.93 | 2,520,492 | 708,984 | 3,229,476 | 4.7% | of TDC |
| (9) Paint | 410 | 77.08 | 31,626 | 7,037 | 38,663 | 0.1% | of TDC |
| **Total Direct Field Costs** | **219,762** | **112.20** | **24,656,898** | **44,516,837** | **69,173,735** | 100.0% | of TDC |
| | (TDMH) | | (TDL) | (TDM) | (TDC) | | |
| | | | | | | | |
| | | | | | | | |
| Constrution Management | | | | | 3,458,687 | 5.0% | of TDC |
| Owner's Costs | | | | | 5,533,899 | 4.2% | of TIC |
| Spare Parts | | | | | 887,670 | 3.0% | of EQP |
| Vendor Representatives | | | | | 591,781 | 2.0% | of EQP |
| Freight | | | | | 1,335,500 | 3.0% | of TDM |
| Taxes and Permits | | | | | 5,706,801 | 8.25% | of TDC |
| Engineering and HO | | | | | 13,834,748 | 10.5% | of TIC |
| Start-Up | | | | | 415,042 | 0.3% | of TIC |
| **Total Non-Field Costs** | | | | | **31,764,128** | 45.9% | of TDC |
| | | | | | | | |
| **Directs + Indirect Costs** | | | | | **100,937,863** | 145.9% | of TDC |
| | | | | | (D+I) | | |
| | | | | | | | |
| Escalation | | | | | | | of D+I |
| | | | | | | | |
| **Target Costs** | | | | | **100,937,863** | | |
| | | | | | (TGT) | | |
| | | | | | | | |
| Contingency | | | | | 30,262,137 | 30.0% | of TGT |
| | | | | | | | |
| **Project Total Costs** | | | | | **131,200,000** | 189.7% | of TDC |
| | | | | | (TIC) | | |

Notes: 1) All Costs are 3rd quarter 2022 with no forward escalation.
2) Productivity is 65% of ACCE base units.

# 16. Appendix 3: HF Decommissioning Costs

**Table 4: HF Alkylation Unit Decommission Cost**

**Aspen Capital Cost Estimator**

*Project Cost Summary*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Project Title:* | E112.00 HF ALKYLATION DEMOLITION LONGVIEW TEXAS | | | | | | |
| *Project Name:* | HF ALKYLATION | | | *Scenario Name:* | E112_00 HF ALKYLATION DEMOLITION 202 | | |
| *Proj. Location:* | USA | | *Job No:* | | *Prep. By:* | H WELKER | |
| *Excel Run Date* | 8SEP22 15:03:17 | V12 | *Est. Class:* | Class 4 | *Currency:* | DOLLARS USD | |
| Account | MH | Wage Rate | Labor Cost | Matl Cost | Total Cost | Percentages | |
| (2) Equipment | 95,628 | 118.33 | 11,315,704 | 375,000 | 11,690,704 | 74.0% | of TDC |
| (3) Piping | 9,792 | 125.38 | 1,227,733 | | 1,227,733 | 7.8% | of TDC |
| (4) Civil | 8,616 | 93.70 | 807,302 | | 807,302 | 5.1% | of TDC |
| (5) Steel | 3,177 | 102.75 | 326,413 | | 326,413 | 2.1% | of TDC |
| (6) Instruments | 3,324 | 127.26 | 423,080 | 3,021 | 426,101 | 2.7% | of TDC |
| (7) Electrical | 1,741 | 114.35 | 199,048 | | 199,048 | 1.3% | of TDC |
| (8) Insulation | 11,454 | 98.68 | 1,130,280 | | 1,130,280 | 7.2% | of TDC |
| (9) Paint | | | | | | | of TDC |
| **Total Direct Field Costs** | **133,733** | **115.38** | **15,429,559** | **378,021** | **15,807,580** | 100.0% | of TDC |
| | (TDMH) | | (TDL) | (TDM) | (TDC) | | |
| Constrution Management | | | | | 790,379 | 5.0% | of TDC |
| Owner's Costs | | | | | 1,264,607 | 4.4% | of TIC |
| Taxes and Permits | | | | | 1,304,100 | 8.25% | of TDC |
| Engineering and HO | | | | | 3,161,516 | 10.9% | of TIC |
| **Total Non-Field Costs** | | | | | **6,520,602** | 41.2% | of TDC |
| **Directs + Indirect Costs** | | | | | **22,328,182** | 141.2% | of TDC |
| | | | | | (D+I) | | |
| Escalation | | | | | | | of D+I |
| **Target Costs** | | | | | **22,328,182** | | |
| | | | | | (TGT) | | |
| Contingency | | | | | 6,671,819 | 29.9% | of TGT |
| **Project Total Costs** | | | | | **29,000,000** | 183.5% | of TDC |
| | | | | | (TIC) | | |
| | Notes: | 1) All Costs are 3rd quarter 2022 with no forward escalation. | | | | | |
| | | 2) Productivity is 65% of ACCE base units. | | | | | |