ENERGY

Introduction to Crack Spreads

How the world advances

CME Group

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The energy markets at CME Group serve as a means of price discovery for the international marketplace. The crude oil, gasoline and diesel (ULSD) derivatives contracts offered at CME Group under the rules and regulations of NYMEX, a CME Group exchange, are reliable risk management tools that serve as global benchmarks. All contracts provide the safety and security of central clearing through CME Clearing, whether they are exchange-traded futures contracts or contracts traded over-the-counter and submitted for clearing through CME ClearPort.

This handbook is designed to facilitate trading of the crack spread, which is the spread between crude oil prices and products derived from crude oil processing — gasoline and diesel. It offers detailed explanations of the types of crack spreads and provides numerous examples of how they can be traded.

What is a Crack Spread?

In the petroleum industry, refinery executives are most concerned about hedging the difference between their input costs and output prices. Refiners' profits are tied directly to the spread, or difference, between the price of crude oil and the prices of refined products — gasoline and distillates (diesel and jet fuel).

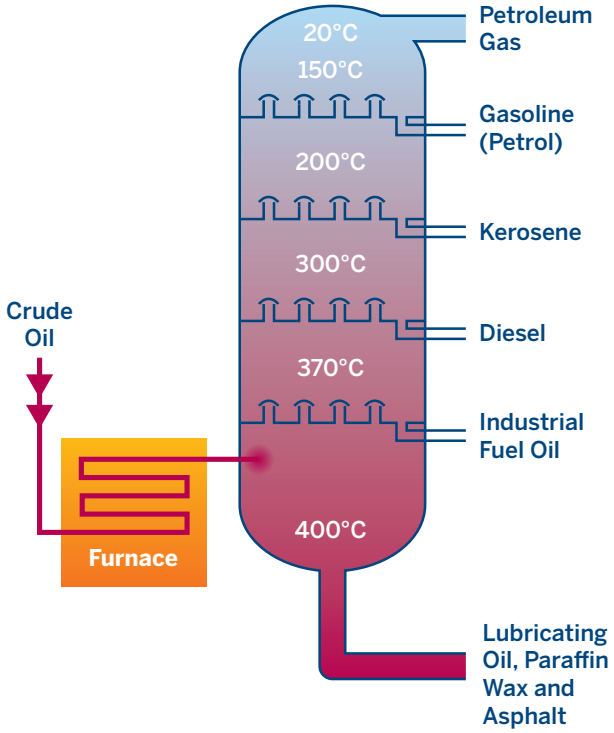
This spread is referred to as a crack spread. It is referenced as a crack spread due to the refining process that "cracks" crude oil into its major refined products.

A petroleum refiner, like most manufacturers, is caught between two markets: the raw materials he needs to purchase and the finished products he offers for sale. The price of crude oil and its principal refined products are often independently subject to variables of supply, demand, production economics, environmental regulations and other factors. As such, refiners and non-integrated marketers can be at enormous risk when the price of crude oil rises while the prices of the refined products remain stable, or even decline.

Such a situation can severely narrow the crack spread, which represents the profit margin a refiner realizes when he procures crude oil while simultaneously selling the refined products into a competitive market. Because refiners are on both sides of the market at once, their exposure to market risk can be greater than that incurred by companies who simply sell crude oil, or sell products to the wholesale and retail markets.

In addition to covering the operational and fixed costs of operating the refinery, refiners desire to achieve a rate of return on invested assets. Because refiners can reliably predict their costs, other than crude oil, an uncertain crack spread can considerably cloud understanding of their true financial exposure.

Further, the investor community may use crack spread trades as a hedge against a refining company's equity value. Other professional traders may consider using crack spreads as a directional trade as part of their energy portfolio, with the added benefit of its low margins (the crack spread trade receives a substantial spread credit for margining purposes). Together with other indicators, such as crude oil inventories and refinery utilization rates, shifts in crack spreads or refining margins can help investors get a better sense of where some companies — and the oil market may be headed in the near term.



Hedging the Crack Spread

There are several ways to manage the price risk associated with operating a refinery. Because a refinery's output varies according to the configuration of the plant, its crude slate, and its need to serve the seasonal product demands of the market, there are various types of crack spreads to help refiners hedge various ratios of crude and refined products. Each refining company must assess its particular position and develop a crack spread futures market strategy compatible with its specific cash market operation.

1. Simple 1:1 Crack Spread

The most common type of crack spread is the simple 1:1 crack spread, which represents the refinery profit margin between the refined products (gasoline or diesel) and crude oil. The crack spread — the theoretical refining margin — is executed by selling the refined products futures (i.e., gasoline or diesel) and buying crude oil futures, thereby locking in the differential between the refined products and crude oil. The crack spread is quoted in dollars per barrel; since crude oil is quoted in dollars per barrel and the refined products are quoted in cents per gallon, diesel and gasoline prices must be converted to dollars per barrel by multiplying the cents-per-gallon price by 42 (there are 42 gallons in a barrel). If the refined product value is higher than the price of the crude oil, the cracking margin is positive. Conversely, if the refined product value is less than that of crude oil, then the gross cracking margin is negative.

When refiners look to hedge their crack spread risk, they typically are naturally long the crack spread as they continuously buy crude oil and sell refined products. If refiners expect crude oil prices to hold steady, or rise somewhat, while products prices fall (a declining crack spread), the refiners would "sell" the crack; that is, they would sell gasoline or diesel (ULSD) futures and buy crude oil futures. Whether a hedger is "selling" the crack or "buying" the crack reflects what is done on the product side of the spread, traditionally, the premium side of the spread.

At times, however, refiners do the opposite: they buy refined products and sell crude oil, and thus find "buying" a crack spread a useful strategy. The purchase of a crack spread is the opposite of the crack spread hedge or "selling" the crack spread. It entails selling crude oil futures and buying refined products futures. When refiners are forced to shut down for repairs or seasonal turnaround, they often have to enter the crude oil and refined product markets to honor existing purchase and supply contracts. Unable to produce enough products to meet term supply obligations, the refiner must buy products at spot prices for resale to his term customers. Furthermore, lacking adequate storage space for incoming supplies of crude oil, the refiner must sell the excess crude oil on the spot market.

If the refiner's supply and sales commitments are substantial and if it is forced to make an unplanned entry into the spot market, it is possible that prices might move against it. To protect itself from increasing product prices and decreasing crude oil prices, the refinery uses a short hedge against crude oil and a long hedge against refined products, which is the same as "purchasing" the crack spread.

2. Diversified 3:2:1 and 5:3:2 Crack Spreads

There are more complex hedging strategies for crack spreads that are designed to replicate a refiner's yield of refined products. In a typical refinery, gasoline output is approximately double that of distillate fuel oil (the cut of the barrel that contains diesel and jet fuel). This refining ratio has prompted many market participants to concentrate on 3:2:1 crack spreads — three crude oil futures contracts versus two gasoline futures contracts and one ULSD futures contract.

In addition, a refiner running crude oil with a lower yield of gasoline relative to distillate might be interested in trading other crack spread combinations, such as a 5:3:2 crack spread. This crack spread ratio is executed by selling the five refined products futures (i.e., three RBOB gasoline futures and two ULSD futures) and buying five crude oil futures contracts, thereby locking in the 5:3:2 differential that more closely replicates the refiner's cracking margins.

3:2:1 crack spreads — *three crude oil futures contracts versus two gasoline futures contracts and one ULSD diesel futures contract.*

Further, professional traders may consider using diversified crack spreads as a directional trade as part of their overall portfolio. Also, the hedge fund community may use a diversified 3:2:1 or 5:3:2 crack spread trade as a hedge against a refining company's equity value.

Crack Spread Options

Crack spread options were introduced by the Exchange in 1992. These options are American-style, which means that they exercise into the underlying futures. Crack spread options complement the futures by allowing the refiner to hedge its operating margin at a known up-front cost, while simultaneously allowing it to participate in any future widening of refining margins. The options give added flexibility to those trying to manage their risk in increasingly fickle physical markets. While crude-to-product ratios of futures crack spreads are tailored by traders to best fit their needs, crack spread options contracts are standardized Exchange instruments which reflect a one-to-one ratio. The one-to-one ratio of the crack spread options meets the needs of many refiners, because it reflects the refiner's exposure related to the manufacture of gasoline and distillate fuel throughout the year.

Crack spread options have strike prices at $.25/barrel intervals. They are somewhat unique in that they exercise into two separate underlying futures (one refined product and one crude oil), instead of the typical one future per option. A call option would exercise into a long refined product (diesel or gasoline) futures contract and a short crude oil contract. Conversely a put option exercises into a short refined product futures and a long crude oil futures. The prices assigned to the individual futures would be at the differential of the strike price on a per barrel basis. They expire on the business day prior to the crude oil futures termination. For a refiner looking to hedge their profit margin, a long put option would be appropriate. For a petroleum consumer wishing to hedge against a widening of the spread, a long call option might be considered.

A long crack call (buying a crack call option), or a short crack put (selling a crack put option), is defined as the assignment of futures positions which, at exercise, involves buying one underlying diesel or gasoline futures contract and selling one underlying crude oil contract.

A long crack put (buying a crack put option), or a short crack call (selling a crack call option), is defined as the assignment of futures positions which, at exercise, involve selling one underlying diesel or gasoline futures contract and buying one underlying crude oil futures contract.

Typically, the refined product is generally at a higher price than the crude oil. For example, if crude oil is at $90.17/barrel, and the option strike price is $10/barrel, the associated refined product upon option exercise would be $2.3850/gallon ($90.17 +$10.00 divided by 42). Infrequently, crack spread options can actually be traded at negative strike prices, i.e. the refined product futures would be at a lower price than the crude oil futures position. For example, if crude oil were priced at $87.06, the strike price were — $.75, the refined product would exercise at $2.0550 ($87.06 — $.75 divided by 42). While the options expire one business day prior to the crude oil futures, they exercise into futures with two different termination dates. Refined products futures tend to terminate about 10 days after the associated crude oil futures contract.

In practice, crack spread options are used to insure against a deterioration of the price differential between the refined product and crude oil. For example, on January 12, 2011, with February crude oil futures trading at $91.86 per barrel, and February ULSD futures at $2.6186 per gallon, a refiner might purchase a February put option with a strike of $18 at a premium of $1.75. The implied crack spread at the time of the trade would be $18.12 [($2.6186 times 42) — $91.86]. Suppose by expiration day on January 19, 2011, the February crude oil futures price rises to $97.00 per barrel, while ULSD futures rises to $2.6686 per gallon. The underlying crack spread would now be $15.08 [($2.6686 times 42) — $97.00]. Since the refiner purchased the $18.00 put option, the option is now in the money by $2.92. Since the refiner paid $1.75, this protects their refining margin by $1.17 ($2.92 — $1.75). In practice, the Exchange would exercise the option into two underlying futures contracts. The ULSD futures contract would be exercised at the crude oil settlement price added to the strike price divided by 42 (rounded to the nearest .0000 or .0050). The crude oil futures contract would be exercised at the diesel exercise price multiplied by 42, less the strike price. In this example, the crack spread option would be exercised into a short ULSD futures contract at $2.7400 per gallon, and a long crude oil futures contract at $97.08 per barrel.

Another example might be a gasoline marketer who is concerned that crack spreads may widen by July. The underlying crack spread is currently $12.88, with the crude oil futures price at $95.48, and the RBOB gasoline futures price at $2.5802. They may purchase a call with a $13.00 strike price at $6.00. If by expiration day, the July RBOB gasoline futures rose to $3.0000/gallon while the crude oil futures rose to $105.00/barrel, the crack spread option would now be valued at $21.00/barrel. The crack spread option would have an in-the-money value of $8.00/barrel on expiration, or a profit of $2.00/barrel. The option would then exercise into a long RBOB gasoline futures contract at $2.8100 per gallon and a short crude oil futures contract at $118.02 per barrel.

Refiners, blenders and marketers *have a flexible hedge against variable refining margins in distillate fuels and gasoline.*

Crack spread options offer a number of benefits:

- **Refiners, blenders and marketers have a flexible hedge against variable refining margins in distillate fuels and gasoline.**
- **"Puts" give refiners an instrument for locking in crude oil cost and product margin without penalty to further market gains.**
- **"Calls" afford product marketers protection during unstable spread increases.**
- **Crack spread options in general furnish traders with an efficient mechanism for hedging the changing relationship between crude oil and refined products.**
- **They allow refiners to generate income by writing options.**
- **A refiner's margin could be hedged by utilizing the appropriate futures contracts, but maintaining the hedge essentially locks him into a predetermined margin. Options give him the right, but not the obligation, to obtain that margin.**
- **Marketers and distributors selling branded and unbranded gasoline can use crack spread options to help maintain their competitive positions in the marketplace. Branded distributors, who are also refiners, can use options to help protect their margins during periods of market instability. Unbranded marketers normally must sell at a discount to the majors. They can find themselves at tremendous risk when the crack spread is severely squeezed in the face of higher crude oil costs. Their wholesale prices may climb much more rapidly than they can raise retail prices because they generally do not have the same flexibility as a refiner, who is selling a wide slate of products. If the refiner chooses, he can hold his gasoline prices relatively steady and pass some of the increased costs through on the prices of other petroleum products. The unbranded marketers can use crack spread options to hedge their margins to avoid getting squeezed if wholesale prices rise.**

Factors Affecting Crack Spread Value

Issue	Typically Affects	Crack Spread Effect
1. **Geopolitical issues** — politics, geography, demography, economics and foreign policy	Crude oil supply	*Crack weakens initially* — higher crude oil prices relative to refined products. *Crack strengthens later,* as refineries respond to tighter crude oil supply and reduce product outputs.
2. **Winter seasonality**	Increase in distillate demand	Crack strength
3. **Slower economic growth**	Decline in refined products demand	Crack weakness
4. **Strong sustained product demand**	High refinery utilization	Crack strength
5. **Environmental regulation on tighter product specifications**	Tightening of product supply	Crack strength
6. **Expiration of trading month**	Cash market realities — long or short products	Cracks values can vary due to closing of positions
7. **Tax increase after certain date**	Increased sales in front of tax deadlines	Crack weakens in front of tax deadline and strengthens post deadline
8. **Summer seasonality**	Increase in gasoline demand	Crack strength
9. **Refinery maintenance**	Decline in product production	Crack strength
10. **Currency weakness**	Crude oil strength	Crack weakness

Cracks are affected by more forces than ever before:

» As investors shift funds into crude oil due to weakness in currencies, crude oil prices can quickly increase causing a decrease in crack spreads.

» The U.S. Renewable Fuels Standard's blending requirements, which displace roughly 6% of refinery hydrocarbon products with renewable products, impact crack spreads by weakening them by introducing new supply sources for demand needs.

Issues to Consider When Implementing Trades

1. **Trade purpose? Trader must understand and be disciplined to trade purpose.**

   a. **Refiner Hedge** — Trying to hedge margins, shutdown time, capital asset purchase, or current market opportunity.

   b. **Investor Opportunity** — Investor perceives market is over- or under-valued and desires to capture current market value. May also be using to complement another equity position in portfolio.

2. **Crack ratio to implement? Simple 1:1 Crack Spread, Diversified 3:2:1 or 5:3:2 Crack Spread.**

   a. **Refiner** — Which crack spread matches your refinery configuration, crude type, and resultant product output?

   b. **Investor** — Which crack spread matches perspective of investor or the refining entity's configuration?

3. **Time period (month, quarter, etc.) of trade?**

   a. If spot market is extremely strong, consider capturing some of that strength at the back of curve if it meets your hedge/trade goals.

   b. Excessively weak market may elicit opportunities to buy undervalued crack spreads.

4. **Buy or sell the Crack Spread?**

   a. "Buying" the crack spread means you "buy" the refined products while selling crude oil. This assumes you expect the crack spread will increase in value, i.e., from $5.00 per barrel to $6.00 per barrel.

   b. "Selling" the crack spread means you "sell" the refined products while buying crude oil. This assumes you expect the crack spread will decrease in value, i.e., from $5.00 to $4.00 per barrel.

Examples

Below are some crack spread trading examples.

Example 1 — Fixing Refiner Margins Through a Simple 1:1 Crack Spread

In January, a refiner reviews his crude oil acquisition strategy and his potential gasoline margins for the spring. He sees that gasoline prices are strong, and plans a two-month crude-to-gasoline spread strategy that will allow him to lock in his margins. Similarly, a professional trader can analyze the technical charts and decide to "sell" the crack spread as a directional play, if the trader takes a view that current crack spread levels are relatively high, and will probably decline in the future.

In January, the spread between April crude oil futures ($90.00 per barrel) and May RBOB gasoline futures ($2.60 per gallon or $109.20 per barrel) presents what the refiner believes to be a favorable 1:1 crack spread of $19.20 per barrel. Typically, refiners purchase crude oil for processing in a particular month, and sell the refined products one month later.

The refiner decides to "sell" the crack spread by selling RBOB gasoline futures, and buying crude oil futures, thereby locking in the $19.20 per barrel crack spread value. He executes this by selling May RBOB gasoline futures at $2.60 per gallon (or $109.20 per barrel), and buying April crude oil futures at $90.00 per barrel.

Two months later, in March, the refiner purchases the crude oil at $100.00 per barrel in the cash market for refining into products. At the same time, he also sells gasoline from his existing stock in the cash market for $2.75 per gallon, or $115.50 per barrel. His crack spread value in the cash market has declined since January, and is now $15.50 per barrel ($115.50 per barrel gasoline less $100.00 per barrel for crude oil).

Since the futures market reflects the cash market, April crude oil futures are also selling at $100.00 per barrel in March — $10 more than when he purchased them. May RBOB gasoline futures are also trading higher at $2.75 per gallon ($115.50 per barrel). To complete the crack spread transaction, the refiner buys back the crack spread by first repurchasing the gasoline futures he sold in January, and he also sells back the crude oil futures. The refiner locks in a $3.70 per barrel profit on this crack spread futures trade.

The refiner has successfully locked in a crack spread of $19.20 (the futures gain of $3.70 is added to the cash market cracking margin of $15.50). Had the refiner been un-hedged, his cracking margin would have been limited to the $15.50 gain he had in the cash market. Instead, combined with the futures gain, his final net cracking margin with the hedge is $19.20 — the favorable margin he originally sought in January.

In January, Refiner sells the 1:1 Gasoline Crack Spread Futures contract at $19.20:
- **Sells 1 May RBOB gasoline futures contract at $2.60 per gallon ($109.20 per barrel)**
- **Buys 1 April CL futures contract at $90.00 per barrel**
- **Locks in the crack spread at $19.20 per barrel**

In the Cash Market in March, Refiner sells the Gasoline Crack Spread at $15.50:
- **Sells 1000 barrels of physical gasoline at $2.75 per gallon ($115.50 per barrel)**
- **Buys 1000 barrels of physical crude oil at $100.00 per barrel**
- **Receives a positive cracking margin of $15.50 per barrel**

In March, Refiner buys back (liquidates) the 1:1 Gasoline Crack Spread Futures contract at $15.50 per barrel:
- **Buys 1 May RBOB gasoline futures contract at $2.75 per gallon ($115.50 per barrel)**
- **Sells 1 April CL futures contract at $100.00 per barrel**
- **Futures gain of $3.70 per barrel (which can be applied to the cash market cracking margin)**

Profit/Loss calculation:
- **Hedged crack spread = $19.20 per barrel**
- **Un-hedged cash market cracking margin = $15.50**

Example 2 — Refiner with a Diversified Slate Hedging with the 3:2:1 Crack Spread

An independent refiner who is exposed to the risk of increasing crude oil costs and falling refined product prices runs the risk that his refining margin will be less than anticipated. He decides to lock-in the current favorable cracking margins, using the 3:2:1 crack spread strategy, which closely matches the cracking margin at the refinery.

On September 15, the refiner decides to "sell" the 3:2:1 crack spread by selling two RBOB gasoline futures and one ULSD futures, and buying three crude oil futures, thereby locking in the 3:2:1 crack spread of $27.40 per barrel. He executes this by selling two December RBOB gasoline futures at $3.00 per gallon ($126.00 per barrel) and one December ULSD futures at $3.10 per gallon ($130.20 per barrel), and buying three November crude oil futures at $100.00 per barrel.

One month later, on October 15, the refiner purchases the crude oil at $110.00 per barrel in the cash market for refining into products. At the same time, he also sells gasoline from his existing stock in the cash market for $3.10 per gallon ($130.20 per barrel) and diesel fuel for $3.20 per gallon ($136.50 per barrel). The 3:2:1 crack spread value in the cash market has declined since September, and is now $21.60 per barrel.

Since the futures market closely reflects the cash market, November crude oil futures are also selling at $110.00 per barrel — $10 more than when he purchased them. December RBOB gasoline futures are also trading higher at $3.10 per gallon ($130.20 per barrel) and December ULSD futures are trading at $3.20 per gallon ($134.40 per barrel). To liquidate the 3:2:1 crack spread transaction, the refiner buys back the crack spread by first repurchasing the two gasoline futures and one ULSD futures he sold in January, and he also sells back the three crude oil futures. The refiner locks in a $5.80 per barrel profit on this crack spread futures trade.

The refiner has successfully locked in a 3:2:1 crack spread of $27.40 (the futures gain of $5.80 is added to the cash market cracking margin of $21.60). Had the refiner been un-hedged, his cracking margin would have been limited to the $21.60 gain he had in the cash market. Instead, combined with the futures gain, his final 3:2:1 cracking margin with the hedge is $27.40 — the favorable margin he originally sought in January.

On September 15, Refiner sells the 3:2:1 Crack Spread Futures contract at $27.40:
- **Sells 2 Dec RBOB gasoline futures contracts at $3.00 per gallon ($126.00 per barrel)**
- **Sells 1 Dec ULSD futures contract at $3.10 per gallon ($130.20 per barrel)**
- **Buys 3 Nov CL futures contracts at $100.00 per barrel**
- **Locks in the 3:2:1 crack spread at $27.40 per barrel**

One Month Later, in the Cash Market on October 15, Refiner sells the 3:2:1 Crack Spread at $21.60:
- **Sells 2000 barrels of physical gasoline at $3.10 per gallon ($130.20 per barrel)**
- **Sells 1000 barrels of physical diesel at $3.20 per gallon ($134.40 per barrel)**
- **Buys 3000 barrels of physical crude oil at $110.00 per barrel**
- **Receives a positive 3:2:1 cracking margin of $21.60**

On October 15, Refiner buys back (liquidates) the 3:2:1 Crack Spread Futures contract at $21.60 per barrel:
- **Buys 2 Dec RBOB gasoline futures contracts at $3.10 per gallon ($130.20 per barrel)**
- **Buys 1 Dec ULSD futures contract at $3.20 per gallon ($134.40 per barrel)**
- **Sells 3 Nov CL futures contracts at $110.00 per barrel**
- **Futures gain of $5.80 per barrel (which can be applied to the cash market cracking margin)**

Profit/Loss calculation:
- **Hedged 3:2:1 crack spread = $27.40 per barrel**
- **Un-hedged cash market cracking margin = $21.60**

Example 3 — Purchasing a Crack Spread (or Refiner's Reverse Crack Spread)

The "purchase" of a crack spread is the opposite of the crack spread hedge or "selling" the crack spread. It entails selling crude oil and buying refined products. Refiners are naturally long the crack spread as they continuously buy crude oil and sell refined products. At times, however, refiners do the opposite: they buy refined products and sell crude oil, and thus find "purchasing" a crack spread a useful strategy.

When refiners are forced to shut down for repairs or seasonal turnaround, they often have to enter the spot crude oil and refined products markets to honor existing purchase and supply contracts. Unable to produce enough refined products to meet supply obligations, the refiner must buy products at spot prices for resale to customers. Furthermore, lacking adequate storage space for incoming supplies of crude oil, the refiner must sell the excess crude oil in the spot market.

If the refiner's supply and sales commitments are substantial and if it is forced to make an unplanned entry into the spot market, it is possible that prices might move against it. To protect itself from increasing refined products prices and decreasing crude oil prices, the refinery uses a short hedge against crude oil and a long hedge against refined products, which is the same as "purchasing" the crack spread.

The "reverse crack spread" is also a useful strategy for professional traders as a directional move if traders take a view that current crack spread levels are relatively low, and will probably rise in the future.

In this example, the refiner is planning for upcoming maintenance, and decides to "buy" the simple 1:1 crack spread in January by buying RBOB gasoline futures, and buying crude oil futures, thereby locking in the current $15.00 per barrel crack spread value. He executes this by buying May RBOB gasoline futures at $2.50 per gallon (or $105.00 per barrel), and selling April crude oil futures at $90.00 per barrel.

Two months later, in March, when the refiner begins the refinery maintenance, he sells the crude oil at a lower price of $80.00 per barrel in the cash market because of the refinery closure. At the same time, he also buys gasoline in the spot market for $2.60 per gallon, or $109.20 per barrel. The crack spread value in the cash market has increased since January, and is now $29.20 per barrel ($109.20 per barrel gasoline less $80.00 per barrel for crude oil).

Since the futures market reflects the cash market, April crude oil futures are also selling at $80.00 per barrel in March — $10.00 less than when he purchased them in January. May RBOB gasoline futures are trading higher at $2.60 per gallon ($109.20 per barrel). To complete the crack spread transaction, the refiner liquidates the crack spread by first selling the gasoline futures he bought in January, and he buys back the crude oil futures, at a current level of $29.20 per barrel. The refiner locks in a $14.20 per barrel profit on this crack spread futures trade ($29.20 per barrel less the $15.00 per barrel crack spread in January).

The refiner has successfully hedged for the rising crack spread (the futures gain of $14.20 is added to the cash market cracking margin of $15.50). Had the refiner been un-hedged, his margin would have been limited to the $15.50 gain he had in the cash market. Instead, combined with the futures gain, his final net cracking margin with the hedge is $29.20.

In January, Refiner buys the 1:1 Gasoline Crack Spread Futures contract at $15.00:
- **Buys 1 May RBOB gasoline futures contract at $2.50 per gallon ($105.00 per barrel)**
- **Sells 1 April CL futures contract at $90.00 per barrel**
- **Hedges the crack spread at $15.00 per barrel**

In the Cash Market in March, Refiner buys the Gasoline Crack Spread at $29.20:
- **Buys 1000 barrels of physical gasoline at $2.60 per gallon ($109.20 per barrel)**
- **Sells 1000 Barrels of physical crude oil at $80.00 per barrel**
- **The cracking margin has increased to $29.20 per barrel**

In March, Refiner sells (liquidates) the 1:1 Gasoline Crack Spread Futures contract at $29.20 per barrel:
- **Sells 1 May RBOB gasoline futures contract at $2.60 per gallon ($109.20 per barrel)**
- **Buys 1 April CL futures contract at $80.00 per barrel**
- **Futures gain of $14.20 per barrel (which is applied to the $15.00 crack spread from January)**

Profit/Loss calculation:
- **Hedged crack spread = $29.20 per barrel**
- **Un-hedged cash market cracking margin = $15.00**

Example 4 — Replicating a Refiner's 3:2:1 Crack Spread with Crack Spread Options

Underlying crack spread options are ratios of one diesel or gasoline futures contract to one crude oil contract. By using multiple options contracts, refiner's hedges can be replicated, such as the 3:2:1 spread (three crude oil futures, two gasoline futures, one diesel futures contract) which is more indicative of many refinery runs.

Two gasoline crack spread options =
two gasoline futures and 2 crude oil futures.

One diesel crack spread option =
one diesel future and 1 crude oil future.

Result: Three crude oil, two gasoline, one diesel.

A futures crack spread executed on the Exchange is treated as a single transaction for the purpose of determining a market participant's margin requirement. Specifically, the minimum margin requirement takes into account that the risk on one side of the spread is generally reduced by the other leg of spread. Similarly, crack spread options allow the hedge to be accomplished with the payment of one options premium instead of two. Crack spread options also offer the inherent advantages of outright options on futures which allow market participants with commercial exposure to tailor their hedge to their price risk without giving up the ability to participate in favorable market moves.

Example 5 — Setting a Floor with Crack Spread Options

Locking in a positive crack spread by itself doesn't necessarily guarantee a profitable refining margin if it doesn't meet the fixed and operating costs of running the plant.

A refiner who is buying crude oil for $100.00 per barrel and selling gasoline at $2.75 per gallon ($115.50 per barrel) has a crack spread of $15.50 per barrel. Of that, $5.00 may be fixed and operating costs, leaving a net refining margin of $10.50.

As long as the refined products/crude oil differential remains above $5.00 per barrel, the refiner can justify operations. When demand for refined product is good or crude oil prices are low, there should be ample opportunity to lock in profits. The lower a refiner can keep the break-even point, the more aggressively it can hedge its profit margin.

A refiner may pay to guarantee covering its costs, yet may be in a position to profit from a favorable move in the market. When refining margins are low, it is difficult to convince management to hedge the entire future production and lock in a break-even price, incurring the risk of an opportunity cost if product prices move higher.

Conversely, the decision becomes an easy one when a participant can lock in strong margins with a single trade. Crack spread options afford the greatest flexibility in seeking to hedge (or capture) these refining margins. With a single trade and a single price, two independent areas of risk can be hedged.

Let's take another look at the refiner who has a $5.00 break-even point and a gasoline crack spread trading at $15.50 per barrel. The question is, how it can best lock in the $10.50 profit margin, and to what extent is it comfortable with that level of profitability?

By buying 50 April RBOB gasoline crack spread puts with a strike price of $15.50 per barrel, the refiner has effectively hedged the cost of purchasing 50,000 barrels of crude oil and the revenue from the sale of 50,000 barrels of gasoline. The futures contracts that underlie each crack spread options contract represent 1,000 barrels of crude oil and 42,000 gallons (equivalent to 1,000 barrels) of refined products.

If taken to expiration and exercised, the refiner will sell gasoline for $15.50 per barrel over crude oil. The hedge guarantees that neither a rise in crude oil prices nor a fall in gasoline prices can eat away at the refining margins below $15.50. For that cost of the options premium, a profit margin has been locked in for 50,000 barrels of output.

For more information about Crack Spreads,
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