PENGIRAAN INDEKS PENCEMAR UDARA (IPU)

AIR POLLUTANT INDEX (API) CALCULATION

Pengiraan IPU ini berdasarkan sistem *Pollution Standard Index* (PSI) yang diterima pakai di peringkat antarabangsa oleh United States Environmental Protection Agency (USEPA).

API calculation is based on Pollution Standard Index (PSI) that has been accepted at the international level by United States Environmental Protection Agency (USEPA)

PENGUKURAN 6 PARAMETER PENCEMAR

MEASUREMENT OF 6 POLLUTANT PARAMETERS

PARAMETER PENCEMAR ***POLLUTANT PARAMETER***
Sulfur dioksida *Sulphur dioxide*
Habuk Halus (PM_{10}) *Particulate matter(PM_{10})*
Habuk Halus ($PM_{2.5}$) *Particulate matter($PM_{2.5}$)*
Ozon *Ozone*
Nitrogen Dioksida *Nitrogen dioxide*
Karbon Monoksida *Carbon monoxide*

PENGIRAAN INDEKS PENCEMAR UDARA (IPU)

AIR POLLUTANT INDEX (API) CALCULATION

- Kiraan purata bagi setiap parameter diambil mengikut tempoh masa berlainan.

  The average calculation for each parameter is taken at different range of periods.

- Hal ini kerana had tempoh pendedahan yang berlainan yang boleh diterima oleh manusia.

  This is because they have different exposure periods that are acceptable to humans.

PENGIRAAN INDEKS PENCEMAR UDARA (IPU)

AIR POLLUTANT INDEX (API)CALCULATION

PARAMETER PENCEMAR *POLLUTANT PARAMETER*	**TEMPOH PURATA** *AVERAGING PERIOD*
Sulfur dioksida *Sulphur dioxide*	1 Jam *1 hour*
Habuk Halus (PM_{10}) *Particulate matter(PM_{10})*	24 Jam *24hours*
Habuk Halus ($PM_{2.5}$) *Particulate matter($PM_{2.5}$)*	24 Jam *24hours*
Ozon *Ozone*	8 Jam *8 hours*
	1 Jam *1 hour*
Nitrogen Dioksida *Nitrogen dioxide*	1 Jam *1 hour*
Karbon Monoksida *Carbon monoxide*	8 Jam *8hours*

PENGIRAAN INDEKS PENCEMAR UDARA (IPU)

AIR POLLUTION INDEX (API) CALCULATION

- Purata kepekatan bagi setiap pencemar mengikut tempoh yang tertentu ini seterusnya diseragamkan menggunakan formula matematik khusus bagi menghasilkan satu nilai yang tidak berunit yang dinamakan sebagai **SUB-INDEKS**.

  *The average concentration of each pollutant over a given period is then standardized using a specific mathematical formula to produce a non-unitary value called **SUB-INDEX**.*

PENGIRAAN INDEKS PENCEMAR UDARA (IPU)

AIR POLLUTION INDEX (API) CALCULATION

- Setiap pencemar akan menghasilkan sub-indeks tersendiri.

  Each pollutant will produce its sub-index.

- Sub-index tertinggi secara relatif akan diambil kira sebagai bacaan IPU.

  The highest relative sub-index will be considered as API reading.

PENGIRAAN INDEKS PENCEMAR UDARA (IPU)

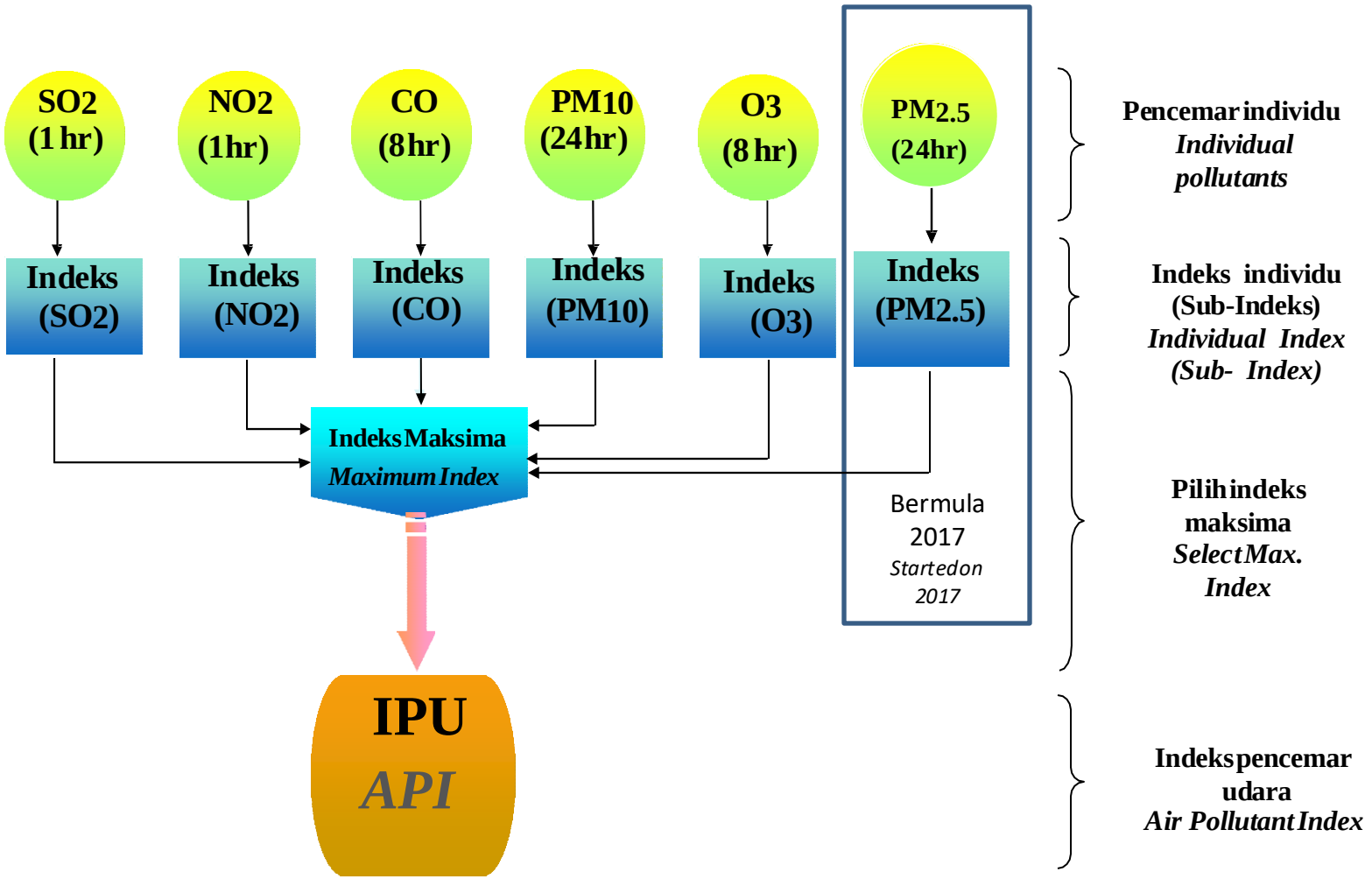
AIR POLLUTION INDEX (API) CALCULATION

- Lazimnya, bacaan IPU adalah ditentukan oleh **kepekatan habuk halus** yang merupakan pencemar dominan pada kebanyakan masa terutamanya semasa berlakunya jerebu di Malaysia.

  *Usually, API readings are determined by the **concentration of particulate matter** that is the dominant pollutant most of the time especially during haze in Malaysia.*

PENENTUAN PENGIRAAN INDEKS PENCEMAR UDARA (IPU)

DETERMINATION OF AIR POLLUTION INDEX (API) CALCULATION



FORMULA SUB-INDEKS BAGI SO_2 YANG TELAH DIMODIFIKASI MENGIKUT STANDARD USEPA

Sub-index formula for SO_2 that has been modified according to USEPA standard

API	Breakpoint of Concentration	Equation for Sub-Index (SI)
x = SO_2 (1h average, unit: ppm)		
0 – 50	$0.000 < x < 0.035$	$SI = \left(\frac{50-0}{0.035-0}\right) \times (x - 0) + 0$
51 – 100	$0.036 \leq x \leq 0.075$	$SI = \left(\frac{100-51}{0.075-0.036}\right) \times (x - 0.036) + 51$
101 – 150	$0.076 \leq x \leq 0.185$	$SI = \left(\frac{150-101}{0.185-0.076}\right) \times (x - 0.076) + 101$
151 – 200	$0.186 \leq x \leq 0.304$	$SI = \left(\frac{200-151}{0.304-0.186}\right) \times (x - 0.186) + 151$
201 – 300	$0.305 \leq x \leq 0.604$	$SI = \left(\frac{300-201}{0.604-0.305}\right) \times (x - 0.305) + 201$
301 – 400	$0.605 \leq x \leq 0.804$	$SI = \left(\frac{400-301}{0.804-0.605}\right) \times (x - 0.605) + 301$
401 - 500	$0.805 \leq x \leq 1.004$	$SI = \left(\frac{500-401}{1.004-0.805}\right) \times (x - 0.805) + 401$

PENGIRAAN SUB-INDEKS SO_2

SO_2 Sub-Index Calculation

x = SO_2 (1h average, unit: ppm)

SI SO_2 = IFS(x<0.036, ((50-0)/(0.035-0)) * (x-0) + 0, x<0.076, ((100-51)/(0.075-0.036)) * (x-0.036) + 51, x<0.186, ((150-101)/(0.185-0.076)) * (x-0.076) + 101, x<0.305, ((200-151)/(0.304-0.186)) * (x-0.186) + 151, x<0.605, ((300-201)/(0.604-0.305)) * (x-0.305) + 201, x<0.805, ((400-301)/(0.804-0.605)) * (x-0.605) + 301, x<1.005, ((500-401)/(1.004-0.805)) * (x-0.805) + 401)

FORMULA SUB-INDEKS BAGI PM_{10} YANG TELAH DIMODIFIKASI MENGIKUT STANDARD USEPA

Sub-index formula for PM_{10} that has been modified according to USEPA standard

API	Breakpoint of Concentration	Equation for Sub-Index (SI)
x = PM_{10} (24h average, unit: µg/m³)		
0 – 50	$0 < x < 54$	$SI = \left(\frac{50-0}{54-0}\right) \times (x - 0) + 0$
51 – 100	$55 \leq x \leq 154$	$SI = \left(\frac{100-51}{154-55}\right) \times (x - 55) + 51$
101 – 150	$155 \leq x \leq 254$	$SI = \left(\frac{150-101}{254-155}\right) \times (x - 155) + 101$
151 – 200	$255 \leq x \leq 354$	$SI = \left(\frac{200-151}{354-255}\right) \times (x - 255) + 151$
201 – 300	$355 \leq x \leq 424$	$SI = \left(\frac{300-201}{424-355}\right) \times (x - 355) + 201$
301 – 400	$425 \leq x \leq 504$	$SI = \left(\frac{400-301}{504-425}\right) \times (x - 425) + 301$
401 - 500	$505 \leq x \leq 604$	$SI = \left(\frac{500-401}{604-505}\right) \times (x - 505) + 401$

PENGIRAAN SUB-INDEKS PM_{10}

PM_{10} Sub-Index Calculation

x = PM_{10} (24h average, unit: µg/m³)

SI PM_{10} = IFS(x<55, ((50-0)/(54-0)) * (x-0) + 0, x<155, ((100-51)/(154-55)) * (x-55) + 51, x<255, ((150-101)/(254-155)) * (x-155) + 101, x<355, ((200-151)/(354-255)) * (x-255) + 151, x<425, ((300-201)/(424-355)) * (x-355) + 201, x<505, ((400-301)/(504-425)) * (x-425) + 301, x<605, ((500-401)/(604-505)) * (x-505) + 401)

FORMULA SUB-INDEKS BAGI $PM_{2.5}$ YANG TELAH DIMODIFIKASI MENGIKUT STANDARD USEPA

Sub-index formula for $PM_{2.5}$ that has been modified according to USEPA standard

API	Breakpoint of Concentration	Equation for Sub-Index (SI)
x = $PM_{2.5}$ (24h average, unit: µg/m³)		
0 – 50	$0 < x < 12.0$	$SI = \left(\frac{50-0}{12.0-0}\right) \times (x - 0) + 0$
51 – 100	$12.1 \leq x \leq 50.4$	$SI = \left(\frac{100-51}{50.4-12.1}\right) \times (x - 12.1) + 51$
101 – 150	$50.5 \leq x \leq 55.4$	$SI = \left(\frac{150-101}{55.4-50.5}\right) \times (x - 50.5) + 101$
151 – 200	$55.5 \leq x \leq 150.4$	$SI = \left(\frac{200-151}{150.4-55.5}\right) \times (x - 55.5) + 151$
201 – 300	$150.5 \leq x \leq 250.4$	$SI = \left(\frac{300-201}{250.4-150.5}\right) \times (x - 150.5) + 201$
301 – 400	$250.5 \leq x \leq 350.4$	$SI = \left(\frac{400-301}{350.4-250.5}\right) \times (x - 250.5) + 301$
401 - 500	$350.5 \leq x \leq 500.4$	$SI = \left(\frac{500-401}{500.4-350.5}\right) \times (x - 350.5) + 401$

PENGIRAAN SUB-INDEKS $PM_{2.5}$

$PM_{2.5}$ Sub-Index Calculation

x = $PM_{2.5}$ (24h average, unit: µg/m^3)

SI $PM_{2.5}$ = IFS(x<12.1, ((50-0)/(12.0-0)) * (x-0) + 0, x<50.5, ((100-51)/(50.4-12.1)) * (x-12.1) + 51, x<55.5, ((150-101)/(55.4-50.5)) * (x-50.5) + 101, x<150.5, ((200-151)/(150.4-55.5)) * (x-55.5) + 151, x<250.5, ((300-201)/(250.4-150.5)) * (x-150.5) + 201, x<350.5, ((400-301)/(350.4-250.4)) * (x-250.5) + 301, x<500.5, ((500-401)/(500.4-350.5)) * (x-350.5) + 401)

FORMULA SUB-INDEKS BAGI O_3 YANG TELAH DIMODIFIKASI MENGIKUT STANDARD USEPA

Sub-index formula for O_3 that has been modified according to USEPA standard

API	Breakpoint of Concentration	Equation for Sub-Index (SI)
x = O_3 (8h average, unit: ppm)		
0 – 50	$0.000 < x < 0.059$	$SI = \left(\frac{50-0}{0.059-0.000}\right) \times (x - 0.000) + 0$
51 – 100	$0.060 \leq x \leq 0.075$	$SI = \left(\frac{100-51}{0.075-0.060}\right) \times (x - 0.060) + 51$
101 – 150	$0.076 \leq x \leq 0.095$	$SI = \left(\frac{150-101}{0.095-0.076}\right) \times (x - 0.076) + 101$
151 – 200	$0.096 \leq x \leq 0.115$	$SI = \left(\frac{200-151}{0.115-0.096}\right) \times (x - 0.096) + 151$
201 – 300	$0.116 \leq x \leq 0.374$	$SI = \left(\frac{300-201}{0.374-0.116}\right) \times (x - 0.116) + 201$

FORMULA SUB-INDEKS BAGI O_3 YANG TELAH DIMODIFIKASI MENGIKUT STANDARD USEPA

Sub-index formula for O_3 that has been modified according to USEPA standard

API	Breakpoint of Concentration	Equation for Sub-Index (SI)
x = O_3 (1h average, unit: ppm)		
101 – 150	$0.125 \leq x \leq 0.164$	$SI = \left(\frac{150 - 101}{0.164 - 0.125}\right) \times (x - 0.125) + 101$
151 – 200	$0.165 \leq x \leq 0.204$	$SI = \left(\frac{200 - 151}{0.204 - 0.165}\right) \times (x - 0.165) + 151$
201 – 300	$0.205 \leq x \leq 0.404$	$SI = \left(\frac{300 - 201}{0.404 - 0.205}\right) \times (x - 0.205) + 201$
301 – 400	$0.405 \leq x \leq 0.504$	$SI = \left(\frac{400 - 301}{0.504 - 0.405}\right) \times (x - 0.405) + 301$
401 - 500	$0.505 \leq x \leq 0.604$	$SI = \left(\frac{500 - 401}{0.604 - 0.505}\right) \times (x - 0.505) + 401$

PENGIRAAN SUB-INDEKS O_3

O_3 Sub-Index Calculation

x = O_3 (8h average, unit: ppm)

SI O_3 (8h) = IFS(x<0.060, ((50-0)/(0.059-0.000)) * (x-0.000) + 0, x<0.076, ((100-51)/(0.075-0.060)) * (x-0.060) + 51, x<0.096, ((150-101)/(0.095-0.076)) * (x-0.076) + 101, x<0.116, ((200-151)/(0.115-0.096)) * (x-0.096) + 151, x<0.375, ((300-201)/(0.374-0.116)) * (x-0.116) + 201)

x = O_3 (1h average, unit: ppm)

SI O_3 (8h) = IFS(x<0.165, ((150-101)/(0.164-0.125)) * (x-0.125) + 101, x<0.205, ((200-151)/(0.204-0.165)) * (x-0.165) + 151, x<0.405, ((300-201)/(0.404-0.205)) * (x-0.205) + 201, x<0.505, ((400-301)/(0.504-0.405)) * (x-0.405) + 301, x<0.605, ((500-401)/(0.604-0.505)) * (x-0.505) + 401)

FORMULA SUB-INDEKS BAGI NO_2 YANG TELAH DIMODIFIKASI MENGIKUT STANDARD USEPA

Sub-index formula for NO_2 that has been modified according to USEPA standard

API	Breakpoint of Concentration	Equation for Sub-Index (SI)
x = NO_2 (1h average, unit: ppm)		
0 – 50	$0.000 < x < 0.053$	$SI = \left(\frac{50-0}{0.053-0.000}\right) \times (x - 0.000) + 0$
51 – 100	$0.054 \leq x \leq 0.100$	$SI = \left(\frac{100-51}{0.100-0.054}\right) \times (x - 0.054) + 51$
101 – 150	$0.101 \leq x \leq 0.360$	$SI = \left(\frac{150-101}{0.360-0.101}\right) \times (x - 0.101) + 101$
151 – 200	$0.361 \leq x \leq 0.649$	$SI = \left(\frac{200-151}{0.649-0.361}\right) \times (x - 0.361) + 151$
201 – 300	$0.650 \leq x \leq 1.249$	$SI = \left(\frac{300-201}{1.249-0.650}\right) \times (x - 0.650) + 201$
301 – 400	$1.250 \leq x \leq 1.649$	$SI = \left(\frac{400-301}{1.649-1.250}\right) \times (x - 1.250) + 301$
401 - 500	$1.650 \leq x \leq 2.049$	$SI = \left(\frac{500-401}{2.049-1.650}\right) \times (x - 1.650) + 401$

PENGIRAAN SUB-INDEKS NO_2

NO_2 Sub-Index Calculation

x = NO_2 (1h average, unit: ppm)

SI NO_2 = IFS(x<0.54 ((50-0)/(0.053-0.000)) * (x-0.000) + 0, x<0.101 ((100-51)/(0.100-0.054)) * (x-0.054) + 51, x<0.361 ((150-101)/(0.360-0.101)) * (x-0.101) + 101, x<0.650 ((200-151)/(0.649-0.361)) * (x-0.361) +151, x<1.250 ((300-201)/(1.249-0.650)) * (x-0.650 + 201, x<1.650 ((400-301)/(1.649-1.250)) * (x-1.250) + 301, x<2.050 ((500-401)/(2.049-1.650)) * (x-1.650) + 401)

FORMULA SUB-INDEKS BAGI CO YANG TELAH DIMODIFIKASI MENGIKUT STANDARD USEPA

Sub-index formula for CO that has been modified according to USEPA standard

API	Breakpoint of Concentration	Equation for Sub-Index (SI)
x = CO (8h average, unit: ppm)		
0 – 50	$0 < x < 4.4$	$SI = \left(\frac{50-0}{4.4-0}\right) \times (x - 0) + 0$
51 – 100	$4.5 \leq x \leq 9.4$	$SI = \left(\frac{100-51}{9.4-4.5}\right) \times (x - 4.5) + 51$
101 – 150	$9.5 \leq x \leq 12.4$	$SI = \left(\frac{150-101}{12.4-9.5}\right) \times (x - 9.5) + 101$
151 – 200	$12.5 \leq x \leq 15.4$	$SI = \left(\frac{200-151}{15.4-12.5}\right) \times (x - 12.5) + 151$
201 – 300	$15.5 \leq x \leq 30.4$	$SI = \left(\frac{300-201}{30.4-15.5}\right) \times (x - 15.5) + 201$
301 – 400	$30.5 \leq x \leq 40.4$	$SI = \left(\frac{400-301}{40.4-30.5}\right) \times (x - 30.5) + 301$
401 - 500	$40.5 \leq x \leq 50.4$	$SI = \left(\frac{500-401}{50.4-40.5}\right) \times (x - 40.5) + 401$

PENGIRAAN SUB-INDEKS CO

CO Sub-Index Calculation

x = CO (8h average, unit: ppm)

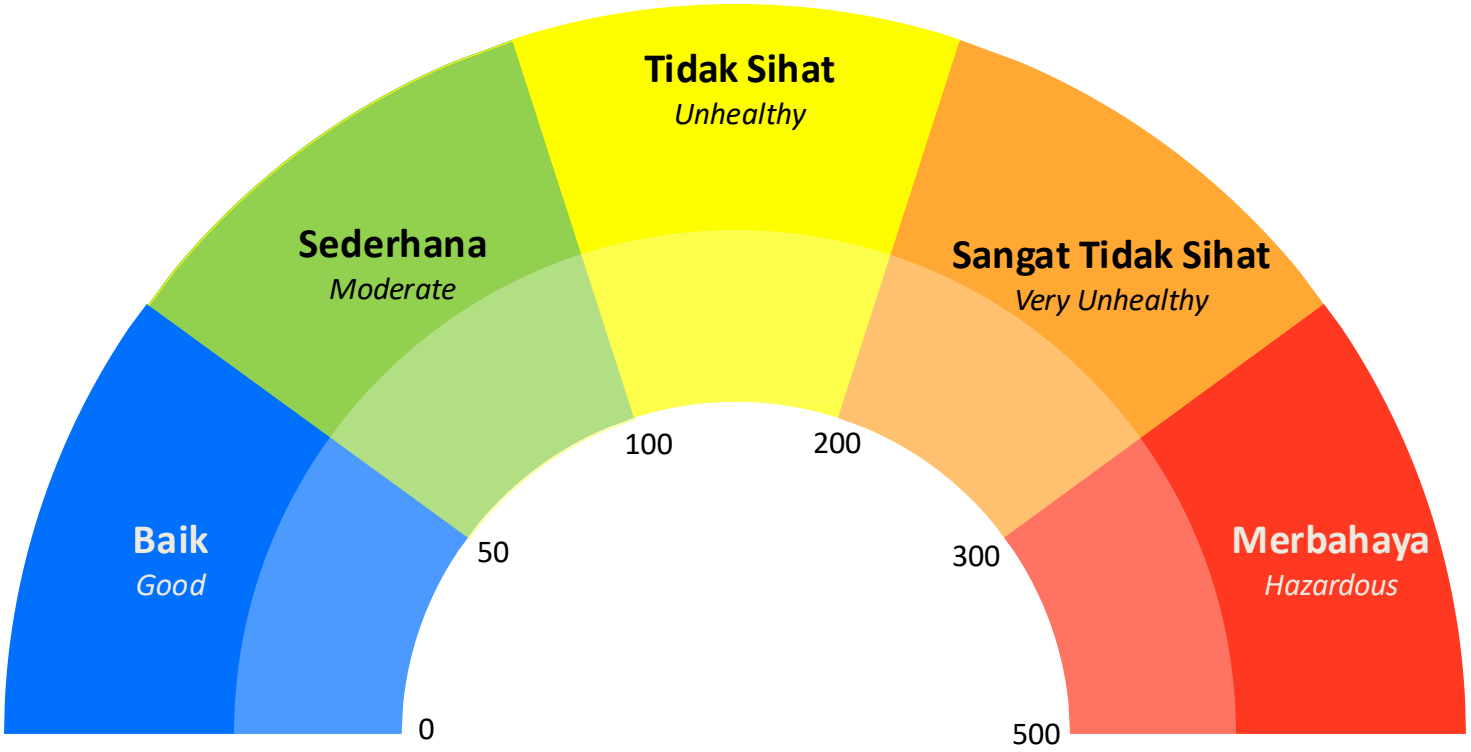
SI CO = IFS(x<4.5 ((50-0)/(4.4-0)) * (x-0) + 0, x<9.5 ((100-51)/(9.4-4.5)) * (x-4.5) + 51, x<12.5 ((150-101)/(12.4-9.5)) * (x-9.5) + 101, x<15.5 ((200-151)/(15.4-12.5)) * (x-12.5) + 151, x<30.5 ((300-201)/(30.4-15.5)) * (x-15.5) + 201, x<40.5 ((400-301)/(40.4-30.5)) * (x-30.5) + 301, x<50.5 ((500-401)/(50.4-40.5)) * (x-40.5) + 401)

PENGIRAAN INDEKS PENCEMAR UDARA (IPU)

AIR POLLUTION INDEX (API) CALCULATION

API = MAX (SI SO2 , SI PM10, SI PM2.5, SI O3 (8h), SI O3 (1h), SI NO2, SI CO)

Penunjuk Status Kualiti Udara = IFS(API<51, “Baik/Good”, API<101, “Sederhana/Moderate”, API<201, “Tidak Sihat/Unhealthy”, API<301, “Sangat Tidak/Very Unhealty”, API<501, “Merbahaya/Hazardous”)



PETUNJUK STATUS KUALITI UDARA

AIR QUALITY STATUS INDICATION

INDEKS PENCEMAR UDARA: KESAN KEPADA KESIHATAN

AIR POLLUTANT INDEX: IMPACT ON HEALTH

IPU *API*	**Status** *Status*	**Kesan kepada Kesihatan** *Health Effect*	**Nasihat Kesihatan** *Health Advice*
0 – 50	Baik *Good*	Pencemaran yang rendah tanpa sebarang kesan buruk terhadap kesihatan. *Low pollution without any bad effecton health.*	Tiada sekatan untuk aktiviti luar kepada orang ramai. Mengekalkan gaya hidup sihat. *No restriction for outdoor activities to the public. Maintain healthylifestyle.*
51 – 100	Sederhana *Moderate*	Pencemaran yang sederhana yang tidak memberi kesan buruk kepada kesihatan. *Moderate pollution that does not pose any bad effect on health.*	Tiada sekatan untuk aktiviti luar kepada orang ramai. Mengekalkan gaya hidup sihat. *No restriction for outdoor activities to the public. Maintain healthylifestyle.*
101 – 200	Tidak sihat (untuk kumpulan yang sensitif) *Unhealthy (for sensitive group)*	Mengurangkan keadaan kesihatan untuk warga tua, wanita hamil, kanak-kanak dan orang-orang yang mempunyai komplikasi jantung dan paru-paru. *Worsen the health condition for elderly, pregnant woman, children and people who is with heart and lungcomplications.*	Aktiviti luar terhad untuk orang berisiko tinggi *Limited outdoor activities for the high risk people.*

IPU *API*	**Status** *Status*	**Kesan kepada Kesihatan** *Health Effect*	**Nasihat Kesihatan** *Health Advice*
201 – 300	Sangat tidak sihat *Very Unhealthy*	Memburukkan keadaan kesihatan dan toleransi yang rendah terhadap latihan fizikal kepada orang yang mempunyai komplikasi jantung dan paru-paru. Mempengaruhi kesihatan awam. *Worsen the health condition and low tolerance of physical exercises to people with heart and lung complications. Affect public health.*	Orang tua dan orang yang mempunyai risiko tinggi dinasihatkan untuk berada di dalam kediaman dan mengurangkan aktiviti fizikal. Orang yang mempunyai komplikasi kesihatan dinasihatkan supaya berjumpa dengan doktor. *Old and high risk people are advised to stay indoor and reduce physical activities. People with health complications are advised to see doctor.*
> 300	Merbahaya *Hazardous*	Berbahaya kepada orang yang berisiko tinggi dan kesihatan awam. *Hazardous to high risk people and public health.*	Orang tua dan orang yang berisiko tinggi dilarang untuk aktiviti luar. Orang awam dinasihatkan untuk mengelak daripada melakukan aktiviti luar. *Old and high risk people are prohibited for outdoor activities. Public are advised to prevent from outdoor activities.*
> 500	Kecemasan *Emergency*	Berbahaya kepada orang yang berisiko tinggi dan kesihatan awam. *Hazardous to high risk people and public health.*	Orang awam dinasihatkan untuk mengikuti arahan dari Majlis Keselamatan Negara dan sentiasa mengikuti pengumuman di media massa. *Public are advised to follow orders from National Security Council and always follow the announcement in mass media.*